CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
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Volume 27 — New York, December 27, 1922 — Number 26

The Centenary of Louis Pasteur

ON DEC. 27, one hundred years ago, LOUIS PASTEUR was born at Dôle, France. His father, JOHN JOSEPH, like his grandfather and great-grandfather, was a tanner. He had also served as sergeant-major under NAPOLEON in the Peninsular campaign, and for it he bore the Cross of the Legion of Honor. There is a legend that he made his own gunpowder in the mountains of Spain, and that old men and women and children followed him and acted as his scouts against the dreadful guerilla commander ESPOZ Y MIÑA. JOHN JOSEPH married JEANNE ETIENNE ROQUI; and of her people, who were plumbers and lampmakers at Salins, it is said that they lived in such amity and good will in their families that "to love like the Roqui" became proverbial.

Their son LOUIS was a good boy. He was deeply religious throughout his life, following ardently the Roman Catholic faith. A deep student, his father frequently urged him not to endanger his health by studying too hard.

But what was the key to his greatness? He showed no sign of brilliancy as a boy. Like JOHN JOSEPH, LOUIS had a taste for drawing and painting, but he was in no way unusual. Many persons are pious and good, although there was only one LOUIS PASTEUR. We think the key to his greatness lay in his passion for work and in the principle which he often repeated: "In the field of observation, chance favors only those who are prepared." He prepared for chemistry by studying and digesting mathematics, physics and crystallography. He urged constantly the aid of physics and crystallography in chemistry—which sounds modern.

Let us follow his work on tartaric and paratartaric or racemic acids. Early as a student of organic chemistry he had been interested in MITSCHERLICH'S work on these bodies and the problem that even that scientist could not solve. The acids seemed identical in the nature, number and arrangement of their atoms, and yet tartaric acid rotated the plane of polarized light, while paratartaric acid remained inactive. Later PASTEUR learned from his friend LAURENT that crystals of very pure sodium tungstate proved, on microscopic examination, to be of three different forms. He published a paper on the rotary polarization of liquids and one on dimorphism, and returned after the interruption of the revolution of '48 to the tartaric acid study. Finally he observed that crystals of tartaric acid and of the tartrates had little faces which theretofore had escaped the attention of observers. They existed on only half the edges or similar angles of the crystals; they were hemihedral in form. He reasoned that this would account for the deviation to the right of the plane of polarization as caused by the tartartes. On the paratartrates he expected to find none of these faces. But alas! close observation proved the paratartrate crystals also to be hemihedral, which was a sore disappointment. Right here we may note the quality of PASTEUR'S genius. He did not stop; and he was prepared. The paratartrate crystals were indeed hemihedral, but the faces of some of the crystals were inclined to the right and of others to the left! Then he sorted them out, one by one, and proceeded with their respective solutions in his polarizing apparatus—and the problem was solved. The hitherto incomprehensible constitution of racemic acid was explained. There was the right-hand tartaric acid, which is the same as that obtained from grapes, and a left-hand acid. The two acids have equal but opposite rotatory powers which neutralize each other when, reduced to an aqueous solution, they are present in equal quantities. There was MITSCHERLICH'S problem solved and the real beginning of stereochemistry.

When we think that in addition to this PASTEUR gave us our understanding of ferments, which promises even greater economies in organic chemical industry; that he discovered the underlying principles of vaccination; that he was the father of biology; that he saved the wine and silk industries of France, put an end to chicken cholera, gave us a vaccine for anthrax and conquered rabies, there is little wonder that a hundred years after his nativity the banners are waving in his honor and we meet to sound his praise.

Absence of Gas Casualties In Military Hospitals

A LARGE part of the propaganda that has been used to create sentiment against chemical warfare has dealt with mysterious gases that have not yet been used, but to which the most deadly character is ascribed. Alleged authorities who, in our opinion, are quite incompetent are quoted in support of the assumption that future methods of warfare will be quite as ruthless as the gases are deadly, and that non-combatants in defenceless towns will be asphyxiated by the million while they sleep. Apparently there is no limit to the imagination of those who draw these gruesome pictures. They wholly disregard the probability that non-combatants will be quite as safe from gas attacks as they now are from long-range artillery and that due warning probably would be given for the evacuation of cities before wholesale destruction was attempted. In short, our friends are creating needless worry for themselves and are crossing bridges long before they are reached.

There are more salient features of chemical warfare to be observed in the casualties of the late war. The argument has frequently been made that chemical warfare was more humane, or, better, less inhumane, than the older and recognized methods. In support of this contention we commend to our anti-chemical warfare enthusiasts a study of the war casualties still receiving attention in military hospitals. The number of gas cases will be found so small as to be negligible, while

the great majority will bear direct testimony to the horrible and inhumane effects of gunfire—shrapnel, high-explosive shells, machine gun and rifle bullets. Eliminate explosives from warfare, and most of the mutilation and maiming of human bodies will disappear. Whatever may be its demerits, gas warfare will not fill post-war hospitals with the casualties of armed conflict. Today there are approximately 20,000 men under treatment in government institutions due to war wounds or disability in military service, but an insignificant and negligible number of these cases are the consequence of gas warfare.

Asking for Bread And Getting a Stone

IT WOULD be impossible as well as futile to pay serious attention to all of the examples of newspaper science that come to our notice, either personally or through the interest of our readers. Most of the specimens merely exhibit laughable ignorance on the part of the reporter or the omniscient conductor of the question and answer column. Occasionally, however, we run across an instance that, in the sheer interest of public safety, calls for exposure and condemnation. We can remain undisturbed or only mildly amused when a newspaper reader is told that sulphuric acid is used largely as an anæsthetic in surgical operations, because we know that the overworked editor strayed into the wrong paragraph in his book of handy reference on scientific subjects. But when an anxious inquirer asks how to make a home-made fire extinguisher and is given a recipe for gunpowder, we protest that the joke is being carried too far.

Being more than merely curious to discover how such misinformation could be dispensed through the columns of reputable newspapers, we pushed the inquiry to a final conclusion. It seems that a central "information bureau" established in the national capital syndicates its service to a number of newspapers in answer to queries that are forwarded to it. The bureau receives several thousand queries a week for information of various sorts. Answers are prepared by a corps of young ladies who depend largely upon government sources of information. But occasionally it is much easier and requires far less time to consult a handy reference work than to make a trip to a government office or try to extract the information by telephone. This is exactly what happened in the gunpowder-fire extinguisher incident. Reference was made to a popular cyclopedia of formulas, and the unsuspecting inquirer was advised to procure "potassium nitrate, 60 oz.; sulphur, 36 oz.; charcoal, 4 oz., colcophar of rouge, 1 oz. Powder separately, dry and mix. This powder is used by placing it in 5-lb. pasteboard boxes, through an orifice in which a fuse is inserted. An extinguisher so made is intended for use in a closed room. It is supposed to act automatically by absorbing oxygen." In the interest of accuracy it must be recorded that the cyclopedia in announcing the formula, stated that "by a slight modification of it we have a recipe for making gunpowder," a bit of information omitted by the newspaper. But even with this saving grace the item is about as useless a piece of information as can be imagined. It is to be hoped that the one who made the inquiry has not yet attempted to use the extinguisher, because if he does he is likely to accelerate rather than extinguish a fire.

No doubt many such examples of newspaper science and misinformation occur in a year, though probably few of them are fraught with possible consequences as dangerous as this one. Chemists and engineers generally should be on the lookout for such items and report them to responsible heads of newspapers publishing them. Conversely newspapers should be encouraged to use the maximum amount of reliable scientific information and advised that local scientists will be glad to assist them in avoiding ludicrous or costly errors.

A Working Balance In Industry

IN ONE of its recent editorials our friend and contemporary *Canadian Chemistry and Metallurgy* very skillfully likens the long-standing controversy of the practical versus the technically trained man in industry to the famous question that Gulliver put to the Lilliputions—viz., Which is the more important end of an egg, the little end or the big end? And just as the conflicting armies of Lilliput forgot that the important thing is the egg itself and not its physical details, so the two parties involved in the other quarrel have lost sight of the fact that they are interdependent and that neither the practical nor the technical man is self-sufficient. Industry depends on both of them and its particular problem is to maintain the sort of balance that promotes co-operation and progress.

We are reminded of a large company in one of our industries that has given serious study to this special phase of human relations. As a result the company boasts of a number of unusual features in its organization. In the first place, its president is a chemist whose name is known to every worker in the industry. So, too, are the general manager of the company's largest works and many of the department heads. Perhaps this is one of the contributing reasons why in the past the company has found it difficult to keep its chemists in the research and control laboratories, so great has been the temptation to enter into operating and executive work. As more and more men left the laboratory it was evident that many of the practical men who had come up from the ranks were being crowded out of positions for which their experience had well qualified them. It was then that the company took notice of this situation and evolved a plan of maintaining what might be called a sort of working balance in industry.

It was decreed that in each department of the plant control should rest with a committee of three men, the superintendent and the two assistant superintendents. One of these men must be a chemist, one must be a practical man drawn from the department's operating personnel and the third must be a mechanical engineer, since in this particular industry much depends upon the construction and maintenance of complicated engineering equipment and apparatus. Instead of crowding out the non-technical man, as previously was the case, this plan opens up a definite pathway for him. He has the opportunity not only to become head of his department but by promotion he may be raised to general manager of the plant or perhaps even to the head of the great organization itself. Likewise the chemist is given a chance to come out of his laboratory shell and to compete for the real plums of his industry.

From the company's viewpoint much is to be gained. The practical man puts to use valuable knowledge and experience gained by hard work and close contact with production. The technically trained man brings a knowledge of basic scientific principles and, more than that, a broadened viewpoint that helps to apply these principles of science to industry. When the proper bal-

ance is reached and these viewpoints are mixed in the right proportion, the industry must prosper. And if we are to judge the effectiveness of this plan by the success of the Standard Oil Company of Indiana, then there are many companies in our industries that would do well to follow this example.

Numbering Of Steel

SPURRED by the activities of the American Engineering Standards Committee, men representing a wide variety of interests recently met in Washington to consider whether it was possible to designate steels by code numbers. That some such scheme would be desirable is generally admitted. In the good old days of straight carbon steels, it was very nice to call them No. 1 temper, No. 2 temper and so on—carbon was the important, the only alloy.

"No. 4 temper" failed to mean anything much when 3 per cent of nickel was added to the metal, so the Society of Automotive Engineers has devised a system of numbering which includes information on the amount of principal alloying element. Such a steel under its nomenclature would be S.A.E. steel 2340. The system is of great value, as is proved by its wide use. So it is rather idle to argue that the steel might better be called 3N40.

But steels of constantly increasing complexity are being offered. The logical system rapidly becomes unmanageable for nickel-chromium steels, with variations in three essential alloys, or for tool steels with four or more. Here lies the advantage of the arbitrary class number adopted by the S.A.E. Nickel-chromium steels are class 3, and tungsten steels are class 7. But even such an artifice has its limitations. Designation 3240 indicates about 2 per cent nickel and 0.40 carbon, but to get any idea of the third essential element, reference to the specification itself must be made.

In passing, it might be remarked that a similar difficulty exists in non-ferrous metallurgy. It is easy to designate deep-drawing brass by 70:30 or naval gun metal by 88:10:2. These are relatively simple combinations of common alloying elements. Several such alloys are standard articles of commerce under well-known names such as admiralty metal or sterling silver—we almost said nickel silver, but reference to a recent list of alloys showed no less than 165 varieties of this! If there is as much difficulty in the designation of time-honored combinations, what is the manufacturer of modern quaternary alloys to do except invent and trademark some word or symbol like duralumin, lynite, 17-S, or Y?

If a logical code indicating the chemical composition of steels and alloys has so far eluded discovery, how much more difficult will it be to devise one which in addition will denote that physical property which, after all, is what is desired and which the chemical composition indicates only dimly. For instance, a steel with 3 per cent nickel (usually 3½ to 3¾) and carbon 0.35 to 0.45 is used for heavy forgings, propeller shafts and gun tubes, for gears of moderate size, connecting rods for locomotives, steam and gas engines, and for rolled structural shapes and bars for long span bridges.

There may not be room for argument that S.A.E. 2340 is a neater way to designate this particular composition than 49S2e, class HG, favored by the U. S. Navy. But proponents of simplified practice in metallurgy should always remember that 3Ni-45C-etc. is only incidental. What an ordnance constructor wants is not a chemical analysis, but a gun tube, and reference to his specification shows that the important thing he is after is high strength and ductility in a direction transverse to the "fiber." Bridge engineers, on the other hand, insist on considerable strength and toughness and reliability in a direction *with* the "fiber"—parallel to the rolling. An automotive engineer designing a gear would be interested in toughness, but probably more in resistance to wear and machinability. Finally, the master car builders or mechanical engineer interested in locomotive connecting rods would require stiffness and resistance to fatigue.

How are you going to get all this into one code without resorting to Chinese characters? The point we are driving at, of course, is that the only known way to describe a steel is in a detailed specification, and even that leaves a great deal to such indefinable items as "judgment" and "good practice." So it makes no great difference whether a steel is called S.A.E. 2340, Navy Department 49S2e, or A.S.T.M. A 8-21, as long as the specification is definite and workable. All of the steels might be indistinguishable chemically; but as one might remark, "Good steel is more than low phosphorus and sulphur."

A Lesson From the A.S.M.E. Convention

DOUBTLESS the readers of *Chem. & Met.* are not accustomed to look to the American Society of Mechanical Engineers for constructive thoughts or helpful ideas in the conduct of the chemical and related industries. It is well, however, to remember that the mechanical engineer is so intimately associated with industry in general that the trend of thought in his national organization is likely to merit the careful consideration of industry as a whole. Witness the campaign of two years ago for the elimination of waste in industry, the keynote of which was sounded at an A.S.M.E. convention. At this year's meeting the keynote was "Economics for Engineers," the A.S.M.E. having joined with the American Economic Association in directing the attention of engineers to the study and application of the broad general principles of the science of economics.

Has this intimate relationship any significance for us as chemical engineers? Does it mean only a combination of mechanical engineering and economics, or does it include engineering in its broadest and most inclusive sense? Obviously the latter. The mechanical engineers are merely giving belated recognition from their branch of engineering to the fact that engineers and economists have many interests in common and that both must contribute to the real end of engineering, which is "the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race." With this fact clearly in mind, the mechanical engineers have set about recasting their mode of thinking so that the principles of economic science may be given proportionate weight in the solution of engineering problems.

The importance of recognizing this relationship is as great in the chemical and related industries as in any other field of human endeavor. The present need of industrial management here as elsewhere is the recognition of fundamental economic truth, and however belated we may be in realizing this condition, it behooves us to bear the point in mind and encourage economics and technology to travel side by side.

Readers' Views and Comments

Chemists in Public Life

To the Editor of Chemical & Metallurgical Engineering

SIR:— In your note following the letter on "Appreciation of the Engineer" in *Chem. & Met.* of Nov. 29, when noting the versatility of the engineer and chemist, you fail to recall any noteworthy instance where they have become well known in religious activities. It is well worth mentioning that Dr. Jesse H. Holmes, professor of philosophy and religion of Swarthmore College, received his doctorate in chemistry, with minors in biology, physics and mineralogy, and until 1900 Dr. Holmes spent a number of years in teaching these sciences. Since 1900 he has been teaching philosophy and history of religions, including the study of the Bible.

A. E. MAZE.

East Orange, N. J.

Why Not Get Away From Traditions?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Why not get away from traditions? Because they are the instruments used in constructing the framework of our social, economic and industrial structures. They are experience.

To the outsider the reason many things are done in industry is obscure. Usually digging deep enough will uncover a sound reason, based probably on experience. Neither the workman himself nor anyone immediately available may be able to give the real reason. Likely as not if asked he will give a wrong explanation.

I presume in the case of the reel oven mentioned in your issue of Nov. 29, it was built with the object of giving what the baker terms a "solid heat." One does not read of "solid heat" and "flash heat" in works on thermodynamics, but they are important nevertheless.

I knew of a reel oven built for breadmaking which had a steel shell covered with insulation; no brickwork at all. In using this it was demonstrated beyond doubt that in order to have the finished loaves weigh the same as exactly the same kind of loaf baked in the ordinary oven of heavy brickwork, it was necessary to allow from a half to one ounce additional weight of dough to each loaf when scaling. And at this time one big bakery was operating at a net profit of one mill per loaf. The significance of this is apparent.

Now as to apparent conservatism. A few years ago the proprietor of one of the big bakeries in the United States said to me, referring to a new type of oven he had installed about a year before: "I'm tearing them out. They're one of the best ovens I ever had, but I can't get them run properly. I have had nothing but trouble with them since I installed them. I can get plenty of men to run the older type as they should be run and I'm going back to them." Here was an instance of a simple type, less efficient, actually producing more satisfactory results than a more efficient one requiring greater skill to produce the best results.

Few industries have made greater advances in the past 40 years than the baking industry. From a trade where mechanical equipment was practically unknown, it has developed until the manufacturing end of a modern baking plant is almost automatic. In at least one year of recent date, statistics show that the baking industry showed a greater return per dollar invested than any other industry in the United States. This affords a pretty fair indication that it has measured up to its opportunities.

The outsider frequently can and does suggest valuable improvements because the man inside is too close to his work to view it in the proper perspective. But sometimes the man inside looks out. A progressive baker wished to eliminate unsightly cracks which, in his eyes, marred the surface of one line of his goods. What suggested a remedy? His observation of the practice of anealing bottles in a glass factory.

Treat that man with suspicion who can "see at a glance" opportunities for improvement. By no means disregard him, but discount him heavily. Improvements can be effected in any plant at any time. Many such which at first sight appear promising prove on closer acquaintance impracticable. Against this appears the unaccountable psychological fact that the same suggestion for improvement that is refused when advanced by the insider is given consideration and executed when put forward by an outsider. Truly a prophet is not without honor save in his own country.

Why does the operating staff in some chemical plants today feel that a specially warm place in the hereafter is reserved for the engineer who designed and built the plant? Isn't it, oftener than not, because the engineer tried to get away from traditions? And when the plant is turned over to the operating crew, where is the engineer? Gone elsewhere, getting away from some more traditions, probably.

"Tradition," says Webster, "hands down the practical arts with more precision and fidelity than they can be transmitted by books." Nothing could be clearer than that. As a rule in the arts the one who really knows cannot and does not express himself in writing. Conversely, the one who writes seldom does so from experience.

Don't try to get away from traditions. They are the tools which countless hands have forged and striven to improve down through the centuries. Master the use of them. With an intimate knowledge of them will come an appreciation of their value. Then, if you can, add to their beauty and utility.

Whitby, Ont. MUNGO E. NASMITH.

Rate of Settling of Clay Suspensions

The rate of settling of clay is thought to be an important matter in connection with the use of clays as a filler in papermaking. The rate of settling of clay in a medium is to a certain extent dependent on the hydrogen-ion concentration of the suspending medium. The rate of settling of six clays has been studied over a wide range of hydrogen-ion concentrations. For each clay-water mixture, there is a definite hydrogen-ion concentration at which the rate of settling will be a maximum, and also a definite concentration at which this rate is a minimum. In the purification of clay, these two points should be known in order to effect the separation of clay particles from quartz and mica particles most efficiently.

Art and Science of Leather Manufacture—II

Preliminary Wetwork: Soaking, Sweating, Loosening Hair by Enzymes, Acids and Liming, Sharpening Agents, Unhairing, Fleshing, Deliming, Drenching, Puering and Bating, Scudding, Pickling—Rounding—Splitting*

By F. L. Seymour-Jones

IN WHATEVER WAY a hide or skin enters a tannery, the first step is to restore it to as near its original condition as possible. In olden times this was accomplished by pegging down the hides in the tannery brook and permitting them to remain there until sufficiently softened. River pollution laws and the loss of hide substance in such a process have caused this method to be abandoned.

Washing or Soaking to Restore Original Condition

Fresh hides are washed in several changes of cold, fresh water, to remove all blood and dirt and to cleanse the hide thoroughly, no special treatment being necessary. A few hours is sufficient; long soaking, or the use of warm or stale water, leads to putrefaction and much damage.

Salted hides require longer soaking, not only to remove the salt but also to plump the fiber so that it may regain its original condition after the dehydration effected by the salt. Longer soaking is possible, owing to the antiseptic powers of the salt. Usually 3 to 4 days' soaking, changing the water at least daily, and preferably with frequent handling (i.e., hauling the hides out and replacing) is adequate. Frequently the soaking is completed by running the hides in a wash wheel—an open-sided drum, through which a stream of water passes—for a few minutes. Salt is, of course, readily soluble in water, and will diffuse the more rapidly the more often the water is changed or the hides handled.

Dry salted and dry hides require more drastic treatment, and are frequently very difficult to soak back into suitable condition. Putrid or stale soaks were largely used, and are still occasionally to be found. In these the dissolved organic hydrolysis products from the hides are permitted to accumulate, and exert—probably by providing suitable nutriment for bacteria—a softening action on the hide. Naturally the danger of damage by bacterial action is great, and hides so treated are liable to much loss of valuable leather-forming hide substance.

Putrid soaks have largely been replaced by the use of chemicals. A great variety have been suggested. Probably the best are dilute organic acids (e.g., formic) or sulphurous acid up to 2 per cent strength. The hides are treated in these liquors for 1 or 2 days, whereby they are swollen and well plumped. Caustic soda (0.1 per cent) and sodium sulphide (up to 0.5 per cent) are largely used, and exert also a preliminary liming effect.

Mechanical Softening

The chemical softening is frequently accompanied also by mechanical softening. For hides the faller stocks are used, kneading and pounding the hide. Skins are frequently "worked on the beam"—i.e., stretched and worked with a blunt knife on a curved-surface table. Both hides and skins may also be tumbled in water in a revolving drum, the mechanical action greatly facilitating the softening (Fig. 5).

The chief danger in soaking, apart from too violent stocking, lies in bacterial action in the soak waters. As previously mentioned, the majority of common disinfectants are barred owing to their tanning action. Sulphurous acid, very dilute phenol, and borax are used as antiseptics here. Even with dilute carbolic acid, the subsequent liming is slowed down considerably. Borax is somewhat costly.

Methods of Removing Hair or Wool

The hides and skins having been brought back to a softened condition, the next operation is to remove the hair or wool. While hair is a byproduct of only small value, the wool of sheepskins is normally of considerably greater value than the pelt, and consequently more care is taken in preserving it than in looking after the skin.

The oldest method of removing hair or wool is that known as sweating, in which a mild putrefaction develops. The hides or skins are hung up in a closed chamber, known as a sweat pit, maintained at an even temperature by double walls or other suitable means. The temperature is kept at 15 to 20 deg. C. by means of steam pipes below the lattice floor, and cold water sprinklers so placed that they do not play on the hides. The air is thus kept saturated with moisture. There is practically no ventilation, and the ammonia liberated by the putrefaction plays a considerable part in loosening the hair. The stench from sweat pits in full operation is terrific, and here lies one cause why tanning in many countries is classed as an offensive trade.

Wool skins (sheep) are treated in a similar manner, a somewhat higher temperature being used. The proc-

FIG. 5—WASHING GREEN HIDES IN DRUMMING WHEELS

*The first article of this series appeared in *Chem. & Met.*, vol. 27, No. 23, p. 1110, Dec. 6, 1922.

FIG. 6—HIDES ROPED TOGETHER OR TOGGLED PRIOR TO REELING IN LIMES

ess is then known as staling. The whole process necessitates very careful supervision to insure that hides are removed before putrefaction has gone too far; otherwise irreparable damage to the grain ensues. In some cases much damage to pelts has been caused by nematode worms during the staling of sheepskins.

While with very careful control sweating offers the advantage, for heavy leather at least, that comparatively little hide substance is lost, its merits are greatly outweighed by the danger of damage to the goods and the excessive and close supervision necessary. Consequently it has very largely been abandoned, and is now used only occasionally for heavy hides, though still to a large extent for sheepskins.

One recent scientific innovation for unhairing is the use of enzymes. A preparation, in which trypsin is the active constituent, has been placed on the market under the name of Arazym. It works quite effectively, though further investigation is necessary to elucidate the nature of enzyme unhairing. Trypsin readily dissolves the young keratin of the hair roots and lower portion of the epidermis, but does not so readily attack the collagenous matter of the true skin unless present in fairly large concentration. Work is in progress along these lines in several laboratories at present, and interesting results may be expected in the course of the next year. Dr. H. C. Ross, working in England, recently patented the use of thrombase for unhairing. Since thrombase is an enzyme developed naturally in the skin itself, this process promises to be of much interest. It is still too recent to permit of any discussion of its practical value.

Another old method of unhairing, which has spasmodically attracted the attention of chemists in recent years, is by the use of dilute acids. A hundred and fifty years ago it was common to unhair in spent, fermented tan liquors, or in barley or grain mash. The process was superseded by the more simple and foolproof method of liming. Acid unhairing is effective, but there is danger that the grain membrane may also be split off from the skin in the form of blisters. The proper conditions for its safe working have not yet been developed.

The standard method of depilation consists in the use of solutions of lime, with or without sharpening agents such as sodium sulphide, sodium hydroxide, arsenic sulphide, etc. Straight limes (i.e., saturated solutions of slaked lime) unhair very slowly under sterile conditions, and there is no doubt that bacteria in the limes, together with degradation products from the hydrolysis of the keratins of the skin (also those from the hide substance), play an important part in unhairing.

There are endless ways of working the limeyard, of which one or two typical may be outlined. The three-pit system is perhaps the most common. In this the hides pass first into an "old" lime liquor (twice before used), then to a medium lime (once used) and finally to a fresh lime. The liquors are always kept saturated, an excess of solid calcium hydroxide being in the pit. The hides are placed in the pit flat, and are hauled (drawn out) and set (replaced) at frequent intervals to hasten the process. Frequently they are roped together, end to end, and reeled over a pulley from one pit to the next. (Fig. 6.) A limeyard in which the packs of hides are handled with an electric traveling crane is shown in Fig. 7.

In another method one pit only is used; the liquor is bettered from time to time by the addition of fresh lime. In this way hydrolysis products tend to accumulate in the lime, providing a fertile culture medium for those bacteria which flourish in lime liquors. Formerly such pits were rarely cleaned out. The three-pit system offers distinct advantages in that the spent liquor is run off after three packs.

Sodium sulphide is now almost universally added to hasten the unhairing action. In water this substance hydrolyzes to form equimolecular proportions of sodium hydrosulphide and hydroxide. Stiasny showed 16 years ago that so long as the proportion of hydroxyl ion to hydrosulphide ion exceeded unity, the unhairing action was good, the optimum being at unity. Where hydrosulphide ion is in excess, unhairing is poor. Consequently when used alone the water used must be soft; otherwise part of the hydroxyl ions are removed in softening the water, and the ratio $[OH]^-:[SH]^-$ becomes less than one, and unhairing is slow.

Sodium sulphide used alone has a very powerful solvent action on the epidermis and hair, and further draws the grain up into rucks. Its use in this respect is usually confined to cheap classes of skins. These are either dipped for a few minutes into a very concentrated solution, or a lime-sulphide paste is swabbed on the flesh side, and the skins piled. The hair can then be brushed off—the brush being made of fiber—or washed off in a wash wheel.

Used in conjunction with lime, the sulphide is employed in dilute solution, 2 oz. per hide being usually sufficient. It is impossible to give exact quantities, as practice varies so enormously.

The use of arsenic sulphide is almost entirely confined to goatskins and the finer quality of sheep. It is

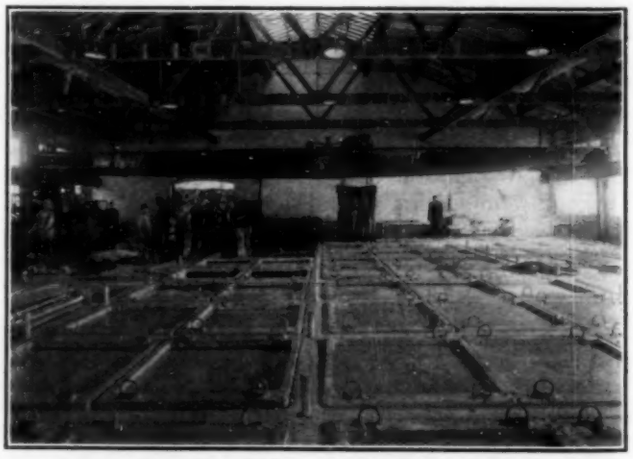


FIG. 7—LIMEYARD WITH ELECTRIC TRAVELING CRANE

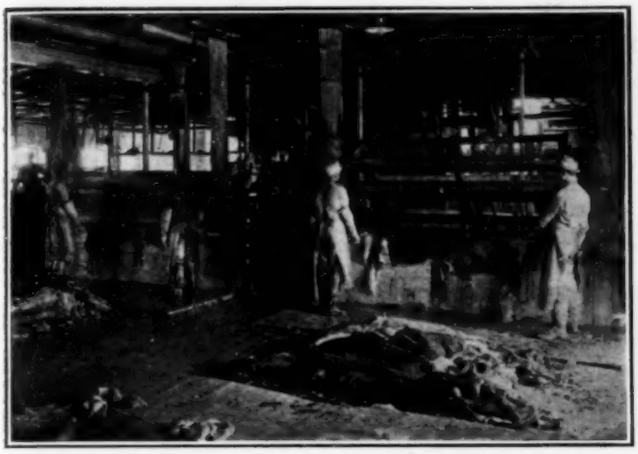


FIG. 8—UNHAIRING WHOLE HIDES

slaked in with the lime, the reaction being highly complicated and the products variable, according to the amount of arsenic used, temperature of slaking, etc. There is no doubt that it provides a finer grain for glazed kid and similar leathers. But it is probable, in the light of recent research, that the result might be obtained by other and cheaper means. The object is to insure that calcium, rather than sodium collagenate, is formed in the limes, by combination between the kation and the skin protein, in accordance with Loeb's work.

Other alkalis can be used for unhairing. Sodium hydroxide swells and plumps (renders firm) the pelt, but unhairing is slow unless the solution is concentrated,

FIG. 9—FLESHING

when the hair is dissolved off. Ammonia readily unhairs, but does not swell or plump the hide. Lime is in general the most suitable. It has very limited solubility and consequently excess can be used with little danger of subsequent damage. It is as near a foolproof material as is possible under technical conditions, although it is by no means difficult to ruin goods in the limeyard.

Stiasny's work showed that liming effects depended largely on the concentration of hydroxyl ion. Consequently anything which can, by interaction with the lime, increase this, will act as a sharpening agent—e.g., sodium oxalate, sulphate, thiosulphate, etc.

The time and nature of liming vary according to the nature of product desired. For sole leather, where a plump, firm product is the object, liming is short and sharp, to loosen the hair and plump the goods. For dressing and harness leather, more mellow liquors are used, to open up the goods to a greater extent. Generally the time varies from 1 week to 3 weeks.

Sheepskins, if they come from a fellmonger (wool puller), have usually been preserved in "gathering limes" after the removal of the wool. Consequently the time of liming will vary according to the amount they have previously received.

FIG. 10—TRIMMING ON THE BEAM

Temperature also plays a part in liming. Although lime is more soluble in cold water than in hot, this is offset by its increased action at higher temperatures. From this a liming process has been devised. Hides are given a very short liming in a lime-sulphide liquor, then pass to warm water (35 to 45 deg. C.) for 12 hours or so, after which they can readily be unhaired.

An ingenious chemical method was devised by Pullman and Payne. The hides are treated first in a sodium hydroxide liquor, followed by a calcium chloride liquor, the object being the formation of lime in the skin. Unless the goods have been treated in a putrid soak, they will not unhair by this method. This process is advantageously used for tanning skins with the hair or fur on.

Various mechanical devices have been brought for-

FIG. 11—INSPECTION BEFORE TANNING

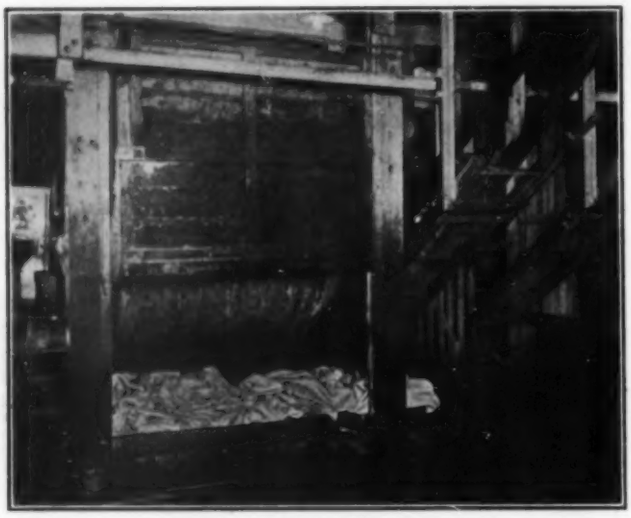


FIG. 12—DELIMING IN DRUMS

ward for hastening liming. A revolving paddle below a false bottom is effective, though likely to be choked by the excess of solid lime. Circulating the liquor with air blast (Forsare process) and suspending the hides combined with a rocking motion (Tilston-Melbourne process) are recent innovations and have met with some application in England. At the limeyard shown in Fig. 6 each vat is thoroughly stirred or plunged with compressed air just before reeling in a string of hides.

From the foregoing it will be seen that liming accomplishes more than merely loosening the hair. With sharp, caustic limes, the hide is swollen and plumped, and the fibers opened up to receive the tan more readily. Long mellow liming tends to remove the interfibrillary substances, and hence to soften the pelt. Greasy skins, such as pig and sheep, have part of their grease converted into lime soaps, whence it is removed by subsequent scudding. There is much to justify the saying that good leather is made before it enters the tanyard.

Unhairing, Fleshing and Deliming

The loosened hair is removed by hand, with a blunt knife over the beam, or, more generally, by machine. One common type consists of a revolving roller fitted with spiral knives which sweeps down a rubber or pneumatic bed on which the hide is laid. Fine hairs are often deep rooted and resistant, and frequently have to be removed afterward by going over the hide with the hand knife. Fig. 8 illustrates the unhairing of the whole hides by machine.

Fleshing may precede or follow liming. In this process all flesh, fat and tissue adhering to the flesh side of the hide are removed, either by hand over the beam with a knife or by machinery. Various types of machines have been developed. All have spiral knifed rollers, against which the hide is pressed by a pneumatic roll, a semi-cylindrical beam, etc. It is usually necessary to finish this operation by hand on the beam. (Fig. 10.) A thorough inspection often follows (Fig. 11) before the hides enter the tanning liquors.

Since all tanning is carried out in an acid medium, and lime precipitates nearly all tannins, it is necessary to remove lime from the skins before proceeding further. For sole leather a surface deliming is often sufficient, while for lighter leathers all lime must be removed to reduce the swelling of the skins and render them soft and flaccid.

The straight chemical process consists in the use of acids. The hides or skins are first washed with water, but removal of lime by this means is slow and always far from complete. Boric acid is used to a limited extent; it is very safe and suitable but somewhat expensive. The common mineral acids, sulphuric and hydrochloric, find most application, but have to be used with care. Excessive concentration of acid (even "dilute" acid) gives a very strong and undesirable swelling. The stock is usually suspended, drummed or paddled, and the acid added very slowly. Organic acids, acetic, lactic, formic, butyric, etc., are being increasingly used with advantage, the chief objection to them being their cost. Even these must not be used in excess. Where skins are being tanned to last for many years (e.g., bookbinding leather), it is essential that *all* treatment with mineral acid be avoided. In the course of time these rot and decay the leathers, leading to that peeling and rubbing away of leather-bound books so familiar today. Many acids of the aromatic series have been suggested, and have a certain antiseptic action, but they have met with little general application. Sulphuric acid, used with caution, is still the most general.

The use of drums and paddles is illustrated in Figs. 12 and 13 respectively. Fig. 13 also gives a closer view of the crane shown in Fig. 7.

Drenching, Bating and Puering

Drenching, though it usually follows (and occasionally replaces) bating, is strictly a deliming process. The drench consists of a fermented infusion of bran, the active agents being *bacterium furfuris* α and β, isolated by J. T. Wood. The cerealin of the bran produces glucose from the starch present, which is in turn attacked by these bacteria. Much gas is evolved, chiefly hydrogen, together with carbon dioxide and nitrogen. Lactic and acetic together with smaller amounts of formic and butyric acids are formed, and these exert the deliming action.

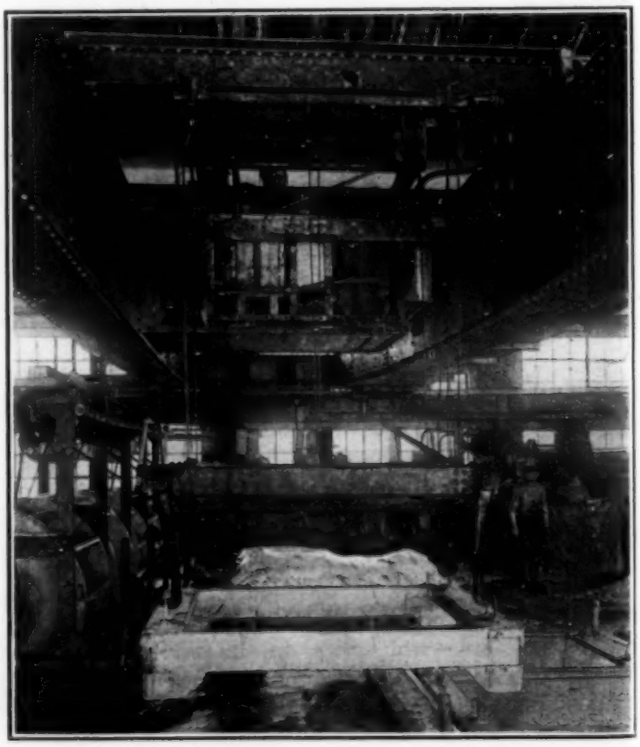


FIG. 13—DELIMING WITH PADDLES

The process is confined to skins, which are drenched in pits, being permitted to rise to the surface, and paddled or poled down again. The temperature is kept about 30 deg. C., and the process lasts 12 to 24 hours. The bran particles have a scouring and cleaning effect on the pelt.

Drenching must not be carried too far, otherwise small blisters form on the grain of the skin, due to the evolution of gas *in* the skin substance. In thundery and sultry weather the drench is apt to sour very rapidly. Some noxious fermentation sets in, and the skins rapidly become glassy and fall to pieces. The cause of this is still obscure.

In no process in the whole of leather manufacture has science done more to improve matters than in bating. Strictly speaking, bating consists in treating hides with infusions of fermented hen and pigeon dung, and puering in similar treatment with dog dung. Both processes are identical in principle, and bating is commonly used in this country to cover not only these two but also the modern method of using artificial (enzyme) bates.

Bating proper, with hen and pigeon dung, is confined to harness and dressing leather, where a mild softening action is required. The strength of the bate varies considerably with the choice of the tanner, the nature of the materials and the effect desired. It is carried out either in the cold by suspending the hides in the bate liquor for 4 to 8 days, or by paddling and drumming the hides at a temperature of about 35 deg. C. The excreta are usually fermented in water for a week, and strained through rough cloth to remove dirt and sediment before use. This process is now largely superseded by the more hygienic enzyme bates.

Puering with dog dung is still extensively used for certain classes of goods, goat and to a lesser degree sheep. The dog dung is mixed to a paste with water and kept in the dark as much out of contact with air as possible. The paste is diluted with water as required, and is strained before use. The skins remain in the liquor for several hours, at a temperature of 20 to 40 deg. C. according to type of stock, and are occasionally stirred or paddled. The completion of puering can be determined only by the feel of the pelt; it should be soft, flaccid and in a completely fallen condition.

Enzyme Bates

During the course of the last 30 years J. T. Wood has made extensive studies of bating and finally traced the main activity of bate liquors to the presence of enzymes. Since that time various enzyme bates have been put on the market, notably "oropon" and "pancreol," consisting usually of trypsin, together with ammonium chloride and a filler of woody fiber or other suitable material. The latter is supposed to furnish a greater surface for the enzyme, as Wood found that the activity of a puer liquor was greatly diminished by filtration, and increased again on the addition of an inert powdery material.

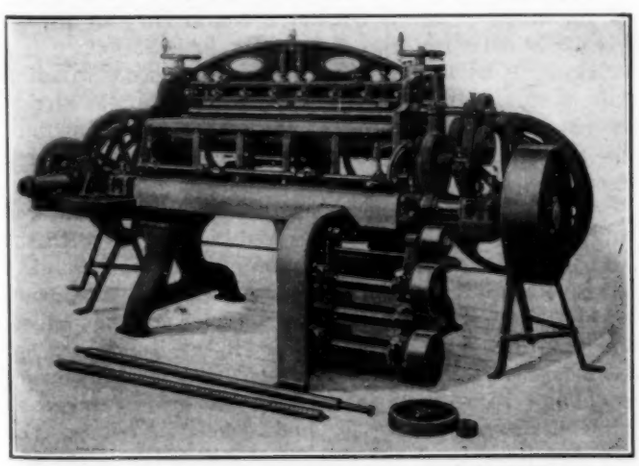


FIG. 14—BELT KNIFE SPLITTING MACHINE

What happens in bating has only recently come to light. It is now known that trypsin hydrolyzes the elastic fibers of the skin, thus loosening the skin structure and removing the binding material of the collagen fiber bundles. This is not all, for skins can be bated without removal of elastin, the finished product being apparently identical in feel and nature. Recent work by J. A. Wilson indicates that commercial bates do *not* digest elastin, while trypsin does; this may be due to absorption of the enzyme by the filler. Probably also the enzyme removes the interfibrillary matter of the skin.

Many patent and secret bates have been put on the market, frequently consisting of various mixtures of fermented or fermentable matter. In general most of these are more of the nature of drenches, but they have met with some application in practice.

Puering is of especial importance in the manufacture of glove leather, to obtain the necessary "stand"—i.e., the skin will not spring back on being stretched. Since the elastic fibers are confined to the grain layer of the skin, it has been suggested that puering may be more effectively carried out by applying a trypsin paste to the grain.

Scudding

Though rarely carried out in this country, the process of scudding usually follows bating in foreign countries. For greasy stock, especially that from animals fed on artificial feeds, it is necessary to remove as much of the skin fats as possible after puering. It is carried out either by hand, over the beam with a blunt knife, or by machine. The machines used are either of the spiral blade type, or, for sheepskins, consist of a number of small, stiff, revolving brushes.

Pickling Prior to Chrome Tanning

Prior to chrome tanning the stock is pickled in a bath of sulphuric acid and salt, followed by a brine bath, just as in the preservation of skins for export by pickling, described in the previous article.

Plumping, Rounding and Splitting

Where hides have been unhaired by enzyme action or by sweating, it is necessary to plump them for purposes where firm leather is required, such as sole. This is accomplished by swelling them in a dilute bath of sulphuric acid.

Hides are frequently rounded prior to tanning—i.e., the offal (bellies and shoulders) is removed, leaving the butt, which may be further divided along the line of the backbone into two bends. The offal, being of less value and looser texture, receives a cheaper tannage.

Hides and skins may be split out of lime or after a preliminary tannage. The split is horizontal, leaving a grain and a "skiver" or flesh. This is usually done on a band knife machine. (Fig. 14.) The knife runs over two pulleys, like an endless belt, and the hide is fed in between two series of rollers, these being adjusted to get the thickness of split desired. Other types of machine, oscillating knife, etc., are also in use. Hide fleshes and

grains are largely used for upholstery, automobile, and bag leathers. Sheepskin skivers are oil tanned for chamois leather, the grains going for hat linings, pocket books, etc.

ACKNOWLEDGMENT

Illustrations for this article were made available through the courtesy of the J. H. Ladew Co., Newark, N. J. (Figs. 5, 6, 8, 9, 10, 11 and 12); Pawling & Harnischfeger, Milwaukee, Wis. (Figs. 7 and 13); Turner Tanning Machinery Co., Peabody, Mass., through the Newark office (Fig. 14).

(Other articles on the art and science of leather manufacture will be printed in subsequent issues.)

Legal Notes

BY WELLINGTON GUSTIN

Junghaus Patent for Luminous Compound Invalid

The U. S. Circuit Court of Appeals has affirmed a decree against the American Radium Co. in its infringement suit against the firm of Hipp, Didisheim & Bro., Inc., and others. Plaintiff is assignee of the Junghaus patent, No. 911,401, covering, as it claims, "certain new and useful improvements relating to improved luminous substance for indicators containing radium for the indicating members of clocks, speed gages, and the like." (279 Federal, 1016.)

Passing over the legal technicalities arising in this case, the patent's validity will be considered. The court found that radium paint, or the luminous material here employed, was old. Phosphorescent paints had long been employed on the hands and dials of clocks, but they were not self-luminous. But it was not long after Mme. Curie discovered radium in 1889 that radium paint appeared. The court says it might well be questioned whether it was invention to apply radium paint, instead of phosphorescent paint. But two distinguished students of radium did apply radium paint before Junghaus, and there was put in evidence the Hammer clock and the Kunz watch.

In 1903 Dr. George F. Kunz, the inventor of a radium paint (letters patent No. 789,912), applied radium paint to the hands and dial of his watch, and that watch was in evidence. Major Hammer put radium paint on his clock in 1903, in much the same way as shown in the Junghaus patent. The court said there was a long list of prior art patents and scientific publication on the subject which might invite discussion, but for these two devices.

OBTAINING HIGH ILLUMINATION BY INCREASING BULK OBVIOUS STEP

Plaintiff contended that Hammer did not think of constructing the dial on his clock so that the luminous substance would be imbedded in the figures on the dial, or that the figures would be imbedded in the luminous substance. Much was argued as to the imbedding of the radium paint. It was contended that the problem which Junghaus was called upon to solve was to apply to the hands of a watch a substantial bulk of a luminous compound, consisting of radium and a radio-responsive material, so as to obtain high illumination, and so that the luminous compound will not extend above the hand, and to apply to the hands of a watch this luminous compound, so that it would extend substantially the full length of each hand, and to obtain this illumination near the indicating divisions on the dial, so that the watch might be readily read in the dark as well as in the daytime.

But there was nothing in the claims about "bulk," and the court concluded that no great importance could have been attached to this feature, else it would have appeared in the claims. The patent states simply: "Preferably the substance is present in some considerable bulk where a high illumination is required."

Obviously to apply the substance in considerable bulk did not require knowledge beyond that of one skilled in the art. This the court says was a mere incidental feature which certainly could not be said to have required inventive genius.

Of course, says the court, it is true that many simple devices have exhibited invention, but on the question of invention a patent case in one art is rarely of much help in deciding whether invention exists in another art. Each case is necessarily controlled by its own facts, and in the case at bar there was nothing left for Junghaus to invent.

Further, the court says that while the decisions of foreign courts are not controlling and often not persuasive, because of a different attitude or a different record, it is sometimes comforting to know that other judicial bodies have come to practically the same conclusion as itself, and the fact that the German and Swiss courts, familiar as they must be with the watch industry, have decided adversely to Junghaus is of special interest.

Cargo Owner Not Entitled to Recover on Policy to Ship Owner

In a suit in admiralty brought by the Virginia Carolina Chemical Co. against the Chesapeake Lighterage & Towing Co. and Fireman's Friend Insurance Co. a decree was had in the U. S. District Court against the insurance company and in favor of the chemical company. On an appeal this decree has been reversed and the case remanded with directions to dismiss the suit, by the Circuit Court of Appeals. (279 Fed., 685.)

The suit as against the Chesapeake company proceeded on the theory that it agreed on due consideration to procure insurance for claimant shipper covering a shipment of kainit. It was admitted this company fulfilled its obligation by procuring or maintaining the Fireman's Friend policy. Therefore the suit shifted to one of damages on insurance. But the court held that a contract by a carrier to obtain insurance for the benefit of the cargo owner is not maritime, and a suit for its breach is not within the Admiralty jurisdiction.

Again, it holds that to entitle a cargo owner to maintain a suit on a maritime policy issued to the carrier he must, under the terms of the contract, have become the insured, when the cargo went on board the carrier's vessel.

And a marine policy issued to a ship owner covered any property on which the insured had agreed with the shipper to provide insurance, and also its legal liability where it had not so agreed, but provided it should not cover "where the assured, or any carrier or other bailee, has insurance which would attach if this policy had not been issued." Here the court held that a cargo owner could not recover on such policy for loss of cargo as "the assured," where it had other insurance, nor through liability of the shipowner where the latter was not charged with any fault.

The Graphical Study Of Operating Efficiency

The Description of a System of Graphs Which Were Developed to Analyze Labor Costs, and Which in Addition Reveal Lack of Smoothness in Operating and the Causes for Lost Time

By A. R. Blakey

IN THIS ARTICLE we shall discuss some recent studies in the field of cost accounting and plant development work, rather as an aid to the operating heads and supervisors than as a help to the accounting department. The studies were designed to indicate opportunities for improving costs by bringing some of the salient facts graphically before the operating executive. The following description is therefore given more to explain the time card and graphic representation of plant troubles than as a significant contribution to cost finding.

The industry under consideration was of the continuous process type and the finished products of several plants were quite similar in percentage consumption and size of containers. The problem as originally faced by the company was to determine at various major points the cost of operation and compare the costs of the several plants with the view of establishing, by comparison, friendly competition for lowest costs and bringing to light those methods which produced the best operating results.

Standardizing Nomenclature and Cost Procedure

Naturally the first step was the standardization of cost procedure and nomenclature. Consequently a very detailed flow sheet of all operations was constructed. It showed them in a logical order and included flow lines for transportation and handling into and through the plant. Following this, a very definite set of rules was laid out and a standard nomenclature adopted for all plants in referring to costs. There was a good deal of discussion as to whether the operations should be numbered according to some systematic code. The decision was finally affirmative, because it would much simplify the recording of time in the field to use a number rather than a word description. Therefore the next step was an examination of the flow sheet and the writing in of numbers to cover all operations represented thereon according to some definite system. The rules adopted in assigning code numbers are given in large part in the footnote.[1]

To make the code numbers available, large placards about 3 ft. square carrying both the description of the work and the several code numbers applicable to it were placed in each department or location where such work was carried out.

A Simple Yet Comprehensive Time Card

Now we have nomenclature, how shall we get the true facts coming in and how shall we visualize them? The answer to question No. 1 is Time Cards, and to question No. 2 Plant Graphs, both of which are described herewith. To anyone who has had field experience with the ordinary time card, the idea of having the individual workman fill out a daily card appeals about as much as ice cream for breakfast. It just doesn't work well. Therefore it was perhaps to be predicted that the regular payroll time cards which were distributed at first, showing total hours worked, together with so-called distribution cards one for each code worked under on which to be written name, payroll number, date, occupation number plus hours spent, etc., were doomed to failure. Cards were lost, torn and soiled, and the men hated them naturally. The clerical work was excessive. The difficulties were somewhat intensified by the awkward plant layout, which was not compact and prevented a centralized distribution of cards.

The time card which finally was worked out and proved very successful combined the ordinary payroll card with the distribution information necessary. The card was designed also to minimize clerical effort by the operator. The time spent on a task could be chalked off on the card directly and at the time of the change of assignment rather than waiting until the end of the day and estimating the time spent on the several codes.

With this card we obtained not only the duration of the task but its sequence in the day's work. We obtained the exact time and duration of such and such a shut-down and what its effects were on the following operation, and how the time of its occurrence was related to some necessary or inherent shut-down of operations or to transportation upon which it was depending. In this way we could look up and down the line and see graphically its cause and effect. The card used is shown herewith. It is divided into two main parts, the upper portion acts as the man's payroll card, the lower portion has the clock spread out upon which he chalks off sequence and duration of events for distribution purposes opposite the proper code.

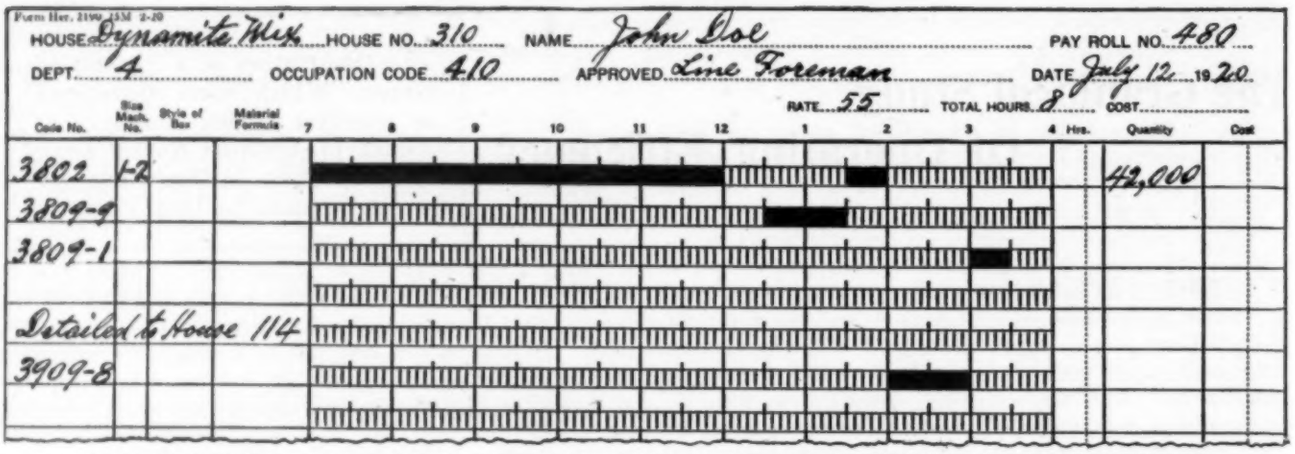
All extensions and arithmetic were done by the office force, and the operator simply chalks off that portion of the clock used in the performance of a given task opposite its code number.

On the reverse side of this card is the "overtime" side, which is quite similar to the straight time side except that it does not repeat name, etc., and the Time Lines begin with 3 instead of 7 o'clock.

How the Executive Gets His Information

So the information was collected on the time consumed in a given task, the ordinary labor charges for the cost accountant. The next step was to portray graphically the workings of the whole plant in one concise picture for the executive and at the same time retain all details of each individual worker. This was accomplished by projecting vertically each individual's time card in its proper place on a "flow sheet" of the

[1] Some of the rules used in assigning the code numbers were as follows:
Use definite groups of numbers for different departments.
All major codes to end in even hundreds as: 100, 200, 300, etc.
All major codes ending in one (1) represent transportation to that operation.
All major codes ending in 2, 3 4, 5, 6, 7 and 8 represent sub-operations at major points.
All major codes ending in 9 represent indirect or non-productive labor, the nature of which may be serialed as 209-2, etc.
All major codes ending in 50 represent repairs, the nature of which to be shown by serial, the serial corresponding to the number painted on machine or part repaired, as 250-5, etc.


HOUSE Dynamite Mix. HOUSE NO. 310 NAME John Doe PAY ROLL NO. 480
DEPT. 4 OCCUPATION CODE 410 APPROVED Line Foreman DATE July 12 1920
RATE .55 TOTAL HOURS 8 COST
Code No. Size Mach. No. Style of Box Material Formula 7 8 9 10 11 12 1 2 3 4 Hrs. Quantity Cost
3802 1-2 42,000
3809-9
3809-1
Detailed to House 114
3909-8

GRAPHICAL TIME CARD SHOWING BOTH TIME CLOCK DATA AND DISTRIBUTION TO CODE NUMBERS

plant, allowing one horizontal line for each time card and having the vertical lines representing time lines for the day. The graph given herewith is such a plant picture.

At first sight it might seem rather a laborious task, but the actual construction of the chart was accomplished by a young grammar school graduate during the forenoon, during which time he also completed the distribution of the payroll.

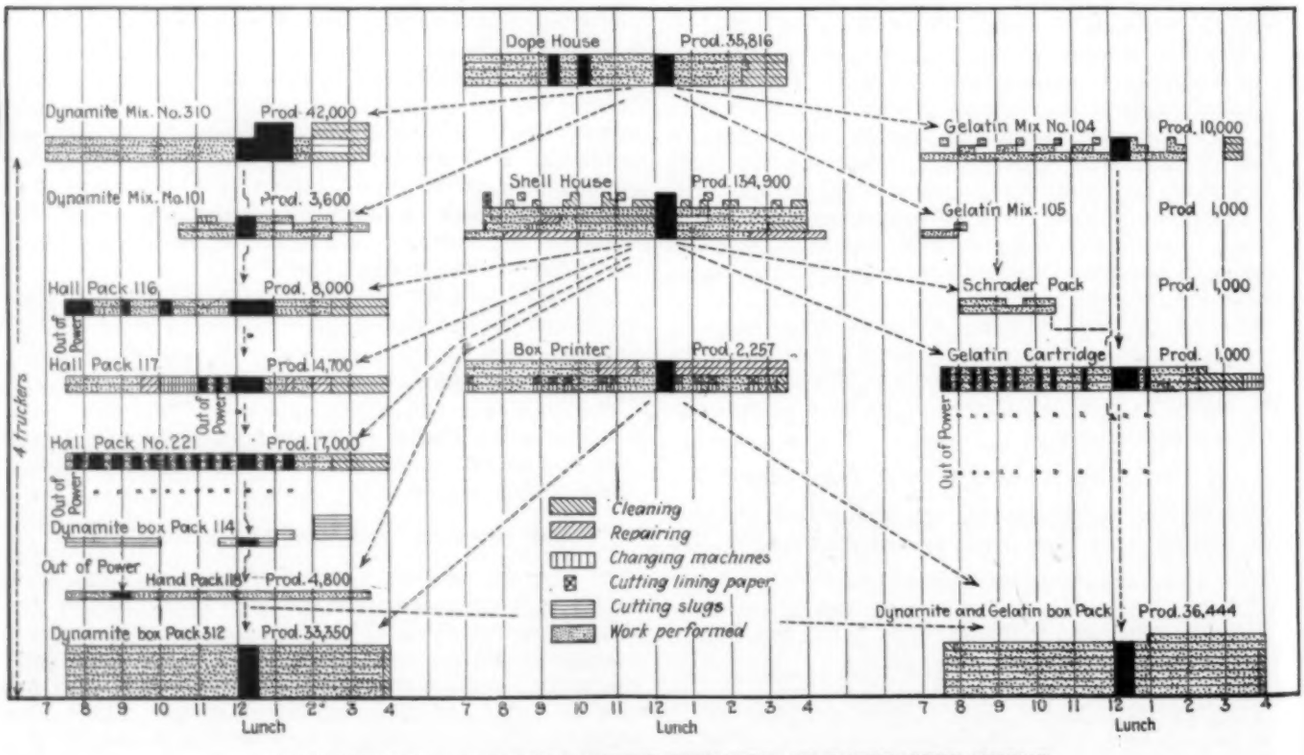
In further explanation of this plant graph and method of plotting, let us consider the Dynamite Mixing House. Here we find there were three men engaged in mixing dynamite from 7 o'clock a.m. until noon without any interruptions. After lunch there were no empty hods for conveying the mixed powder to the packing machines, so the house was idle and the two truckers were there waiting for a delivery until 1:30 p.m. The house then produced until 2 p.m., when they began to clean up, spending one hour and a half at this, during which time the truckers also helped. From 2 to 3 you will note two of the men left the operation and assisted in cutting slugs in Dynamite Box Pack No. 114 and returned at 3 o'clock to their original station and helped in cleaning up.

In Dynamite Box Pack No. 312 you will note there were seven men working without any hold-up except lunch and the clean-up at end of day. From this it is seen that for each man in the house there is a distribution line, and laid off on this line are the intervals as shown on the distribution half of his time card. In making a composite plot of a house these man lines are built one on top of the other corresponding in number to the number of men. The truckers who delivered from building to building appear on the graph only when actually in the house helping the operator with his work.

The time card shown represents the work done by one of the men in Dynamite Mix House No. 310.

In studying these graphs from day to day, the tendencies of the plant are clearly visualized.

The idle intervals showing up in the Gelatin Cartridge are caused by the fact that the Mixing House just


Dope House Prod. 35,816
Dynamite Mix. No. 310 Prod. 42,000
Dynamite Mix. No. 101 Prod. 3,600
Shell House Prod. 134,900
Hall Pack 116 Prod. 8,000
Out of Power
Hall Pack 117 Prod. 14,700
Box Printer Prod. 2,257
Hall Pack No. 221 Prod. 17,000
Dynamite box Pack 114
Out of Power
Hand Pack 115 Prod. 4,800
Dynamite box Pack 312 Prod. 33,350
4 truckers
Gelatin Mix No. 104 Prod. 10,000
Gelatin Mix. 105 Prod 1,000
Schrader Pack Prod. 1,000
Gelatin Cartridge Prod. 1,000
Out of Power
Dynamite and Gelatin box Pack Prod. 36,444
Cleaning
Repairing
Changing machines
Cutting lining paper
Cutting slugs
Work performed
7 8 9 10 11 12 1 2 3 4
Lunch

PLANT GRAPH. THE EXECUTIVE'S SUMMARY OF DAILY OPERATIONS

ahead is under capacity for the cartridge machine. When the reserve Mixing House is thrown in and the cartridge machine kept at capacity, then we have idle intervals in the Mixing House, showing that this section of the line has a poor capacity balance.

Extension of the System Possible

The above system is quite flexible and can be made as detailed or as simple as desired. Instead of having each individual worker make out his distribution, the foreman can make it out for the whole house as the day progresses, where there are not many workers—exactly as each house is here represented. The usual method is for the foreman to write up his house report at the end of the day, giving production figures, time of shutdowns, man-hours, etc., but it is largely guesswork except the production figures; besides, the present house reports are usually such that they do not lend themselves to a continuous record of the events of the day.

If the lower half of each house report had the "time lines" laid off on it so the exact time and duration of these events could be chalked up for each house as they occur, a much more intelligent study with very little work could be made of the average plant which does not care to go into much detail. These house reports could then be assembled quite similarly to the graph shown and the salient points of operation could be quickly noted.

Kenvil, N. J.

The Hygroscopicity of Tetryl and Tetranitraniline

By L. Grier Marsh
Assistant Explosive Chemist, Pittsburgh Station, U. S. Bureau of Mines

THIS WORK is for the main part a continuation of the study of the hygroscopic properties of organic explosives, which on the suggestion of Dr. Charles E. Munroe, chairman of the committee on explosives investigations of the National Research Council, was begun by Huff in his determination of the hygroscopicity of TNT[1] and continued by the author in a previous work on the hygroscopicity of picric acid.[2] The procedure followed in all cases is essentially the same and involves a study of the hygroscopicity from the calculated vapor pressures of saturated aqueous solutions of the substances investigated, and also experimentally determined data on the amount of moisture taken up by each compound by methods previously outlined in detail and briefly summarized below.

The hygroscopicity of TNA has been given by Flurscheim[3] as 0.12 per cent for a material made on a laboratory scale and exposed in an atmosphere of 85 per cent humidity for a week. The uncrystallized material was found to absorb under the same conditions about 0.023 per cent. Constant weight with 0.13 moisture was obtained on a sample of (green) commercial material that had been completely dried in the laboratory at 95 deg. C. A more finely divided yellow TNA became constant after 32 days with 0.19 per cent moisture.[4] The solubility of TNA in water was given as one part in 50,000 at 13 deg. C.

Comparatively little work has been published on the properties of tetryl. Flurscheim states that pure tetryl takes on about 0.30 per cent of moisture at constant weight determined under the same conditions as TNA and that the uncrystallized material attains constant weight with an increase of about 0.024 per cent. Taylor and Rinkenbach, in the Bureau of Mines Explosives Chemical Laboratory, are at present investigating the solubility of tetryl and TNA, and they find the solubility of the pure tetryl in water at 32 deg. to be 0.0088 gram per 100 grams of water. The TNA used had a solubility of 0.0175 part per 100 grams of water.

Calculated Hygroscopicity

Assuming the existence of a close relationship between the hygroscopicity of compounds not forming crystalline hydrates and the vapor pressures of their saturated aqueous solutions and the applicability of Raoult's law to the compounds in question, for the purpose of comparison, the vapor pressure of a saturated aqueous solution of tetryl at 32 deg. can be calculated and a measurement of its hygroscopicity correspondingly determined. From Raoult's law

$$\frac{P_1 - P_2}{P_1} = \frac{n}{N + n}$$

where the solubility of tetryl in water at 32 deg. is taken as 0.0088 per cent and the vapor tension of water at the same temperature as 35.372 mm. of mercury,[5] the vapor pressure of a saturated aqueous solution of tetryl in water at 32 deg. is found to be 35.3718 mm. of mercury, or 99.9994 per cent of that of pure water. The TNA solution had a vapor pressure of 35.3716 mm. of mercury, which is 99.9988 per cent of that of pure water.

TABLE I—VAPOR PRESSURES OF SATURATED SOLUTIONS

	Vapor Pressure of Saturated Aqueous Solutions, Mm. of Mercury	Ratio to Vapor Tension of Pure Water, Per Cent
Picric acid	35.3265	99.872
TNT	35.371427	99.9983
Tetryl	35.371804	99.9994
TNA	35.371591	99.9988

The difference in vapor pressures is so slight that either compound can be only slightly hygroscopic. A comparison between the vapor pressures of saturated aqueous solutions of the different compounds at 32 deg. C. is shown in Table I.

Materials

The experimental work was carried out on both the pure tetryl and TNA and also on two commercial grades of each material containing the ordinary impurities characteristic of each compound.

The purified tetryl was prepared by the following method: Commercial material was dissolved in hot benzene, the solution filtered and permitted to cool. The mother liquid was then decanted and the crystals permitted to air dry. The dried tetryl was then dissolved in hot alcohol, the solution cooled and filtered, the tetryl redissolved in hot alcohol and thrown out of solution by the addition of an equal volume of cold water. The product thus obtained was filtered off, washed once with cold water, twice with cold alcohol, and permitted to dry in a sulphuric acid desiccator for a week.

The pure TNA was prepared by dissolving commer-

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[1] Huff, W. J., "The Hygroscopicity of TNT," *Chem. & Met.*, vol. 21, No. 11, p. 570, Oct. 29-Nov. 5, 1919.

[2] Marsh, L. G., "The Hygroscopicity of Picric Acid," *J. Ind. Eng. Chem.*, vol. 14, No. 4, p. 321, April, 1922.

[3] Flurscheim, B. J., *Z. ges. Schiess-Spreng-stoffw.*, vol. 8, p. 185 (1913).

[4] Flurscheim, B. J., "Some Properties of TNA," *J. Soc. Chem. Ind.*, vol. 40, p. 97t to 107t, May 31, 1921.

[5] Broche and Weibe, Van Nostrand's Chemical Annual, 1918, p. 532.

TABLE II—PROPERTIES OF TETRYL

	Pure Tetryl	Commercial L-364	Commercial M-2356
Melting point (deg. C.)	130.4 to 130.6	127.1 to 129	127.5 to 129.2
Solidification point (deg. C.)	128.6	125.6	126.1
Moisture (per cent)	0.00	0.00	0.00
Insoluble matter (per cent)	0.176	0.713	0.294
Sulphates (H_2SO_4) (per cent)	0.00735	0.00569	0.00541
Ash (per cent)	0.055	0.125	0.14

TABLE III—PROPERTIES OF TNA

	Pure TNA	Commercial L-228	Commercial M-2357
Melting point (deg. C.)	210 to 220	200 to 210	200 to 210
Moisture (per cent)	0.00	0.00	0.00
Insoluble matter (per cent)	0.00	0.112	0.588
Sulphates (H_2SO_4) (per cent)	0.00756	0.0315	0.0834
Ash (per cent)	0.00	0.03	0.300

TABLE IV—HYGROSCOPICITY OF TETRYL AND TNA

	Hours	Grams Increase in Weight Sample	Grams Increase in Weight Blank	Per Cent Moisture Absorbed By Sample
2 grams weight pure tetryl	5	0.0029	0.0021	0.04
	17	0.0031	0.0030	0.00
	24	0.0046	0.0047	0.00
	41	0.0059	0.0052	0.03
	48	0.0062	0.0058	0.02
	72	0.0063	0.0062	0.01
Commercial tetryl L-364	5	0.0119	0.0024	0.47
	17	0.0228	0.0030	0.99
	24	0.0279	0.0027	1.26
	41	0.0379	0.0048	1.65
	48	0.0391	0.0062	1.65
	72	0.0462	0.0064	1.99
Commercial tetryl M-2356	5	0.0047	0.0021	0.13
	17	0.0073	0.0030	0.22
	24	0.0078	0.0047	0.16
	41	0.0091	0.0052	0.20
	48	0.0121	0.0058	0.32
	72	0.0156	0.0062	0.47
Pure TNA	5	0.0024	0.0022	0.01
	17	0.0027	0.0027	0.00
	24	0.0038	0.0027	0.06
	41	0.0043	0.0045	0.01
	48	0.0063	0.0065	0.01
	72	0.0066	0.0061	0.03
Commercial TNA L-228	5	0.0128	0.0022	0.53
	17	0.0272	0.0027	1.22
	24	0.0301	0.0027	1.37
	41	0.0336	0.0045	1.46
	48	0.0386	0.0065	1.62
	72	0.0518	0.0061	2.28
Commercial TNA M-2357	5	0.0153	0.0024	0.65
	17	0.0342	0.0030	1.56
	24	0.0428	0.0027	2.01
	41	0.0541	0.0048	2.47
	48	0.0568	0.0062	2.53
	72	0.0738	0.0064	3.37

cial TNA in hot glacial acetic acid, filtering the solution, crystallizing in the cold, washing the product three times with cold glacial acetic acid and drying in an oven at a temperature from 45 to 50 deg. C. for three days.

The analyses of the different materials are given in Tables II and III.

The determination of the insoluble matter in TNA was made by the use of hot benzene as a solvent, while acetone was used for tetryl.

EXPERIMENTAL

The method used was that designed by Taylor and Cope and given in detail in a previous paper.[6] The essential features of this method involve the determination of the increase in weight of two gram samples of each material after intervals of 5, 17, 24, 41, 48 and 72 hours, where the material is exposed in open porcelain crucibles over water in sealed quart jars, and the jars submerged under water in a large thermostat at a temperature of 32 deg. C. automatically controlled, within a range of 0.10 deg. C. Blank tests on empty crucibles were run in conjunction with the regular tests.

These blanks are necessary especially with materials of low hygroscopicity, as there is a small gain in weight due to the deposition of a film of moisture.[7] This condensation is due to the slight fluctuations in temperature.

The results obtained are shown in Table IV.

CONCLUSIONS

The results obtained show that both pure tetryl and TNA are non-hygroscopic and that the ordinary commercial products are slightly hygroscopic, due to the impurities present.

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[6] "Hygroscopic Properties of Sodium Potassium and Ammonium Nitrate, Potassium Chlorate and Mercury Fulminate," *Chem. & Met.*, vol. 15, No. 3, p. 140, Aug. 1, 1916.

[7] Huff, W. J., "Hygroscopicity of TNT," *Chem. & Met.*, vol. 21, No. 11, p. 570, Oct. 29-Nov. 5, 1919.

Wood Distillation in 1921

Reports made to the Bureau of the Census show a decrease in the activities of the establishments engaged primarily in wood distillation during 1921, as compared with 1919. The total value of products reported amounted to $9,258,500 in 1921, and to $32,545,300 in 1919, a decrease of 71.6 per cent.

Of the 90 establishments reporting products valued at $5,000 or more for 1921, 35 were located in Pennsylvania, 17 in New York, 12 in Michigan, 4 in Louisiana, 3 each in Alabama, Florida, Georgia, New Jersey and Wisconsin, 2 each in Mississippi and North Carolina, and 1 each in Kentucky, Tennessee and West Virginia. Of the active establishments in 1919, 20 were idle in 1921.

The decrease in production has been accompanied by decreases in number of persons employed, in the total amount paid during the year in salaries and wages, and in the cost of materials.

The returns indicate that the combined output of all establishments was approximately 34 per cent of the maximum capacity, based upon a demand requiring full running time; 44 establishments with 36 per cent of the products being above the said average, and 46 with 64 per cent below.

Detailed statistics of products of the wood-distillation industry for the years 1921 and 1919 are given in the following table:

	1921	1919	Per Cent of Decrease
Products—total value	$9,258,500	*$32,625,300	71.6
Wood alcohol:			
Crude, gal.	5,684,500	9,104,000	37.6
Gal.	5,009,300	6,980,700	28.2
Value	$2,307,500	$5,593,500	58.7
Average unit value, gal.	$0.46	$0.80	....
Made and consumed, gal.	675,200	2,123,300	68.2
Refined, gal.	1,111,700	7,391,000	85.0
Gal.	995,300	6,984,700	85.8
Value	$727,500	$8,381,900	91.3
Average unit value, gal.	$0.73	$1.20	....
Made and consumed, gal.	116,400	406,300	71.4
Acetate of lime, lb.	57,927,000	168,956,000	65.7
Lb.	53,563,000	153,910,000	65.2
Value	$736,100	$2,682,200	72.6
Made and consumed, lb.	4,364,000	15,046,000	71.0
Chemicals, in order named as to value:			
Acetic acid, formaldehyde, methyl acetone, acetone, and acetone oil	$411,000	$2,023,300	79.7
Turpentine (from wood):			
Gal.	441,800	1,534,300	71.2
Value	$233,200	$1,207,700	80.7
Rosin (from wood):			
Bbl. (280 lb.)	52,400	234,000	77.6
Value	$199,400	$2,742,500	92.7
Charcoal†:			
Bushels	19,990,000	48,056,000	58.4
Value	$4,049,500	$8,221,400	50.7
Other wood products and derivatives‡	$588,700	$1,220,200	51.8
All other products	$5,600	$552,600	98.1

* Includes byproducts from other industries to the amount of $79,991.

† Does not include products of the charcoal (other than wood distillation) industry to the value of $447,234 for 1921; and $589,418 for 1919.

‡ Includes for 1921: Tar, 1,569,186 gal., $185,450; tar oils, 400,414 gal., $92,400; wood creosote, 92,916 lb. $15,100, and miscellaneous wood products, $295,750.

The Production of Nitrogen and Hydrogen for Synthetic Ammonia Manufacture*

BY HUGH S. TAYLOR
Professor of Physical Chemistry, Princeton University

The Production of Nitrogen and Hydrogen for Synthetic Ammonia Represents at Least 75 Per Cent of the Cost of Production of Ammonia and Yet It Has Had but Little Attention in the Literature—The Efficiencies of Various Methods of Production and Their Future Developments

THE production of 1 ton (2,000 lb.) of fixed nitrogen, as ammonia, involves the theoretical consumption of approximately 430 lb., or more than 82,000 cu.ft., of hydrogen, measured at ordinary temperatures and pressures. One-third of this volume of nitrogen is also required, which may be in part produced simultaneously with the hydrogen or may be wholly supplied from a nitrogen-producing plant. The German synthetic ammonia plants in 1918 had a capacity of 650 metric tons per day. The process is now operated on a technical scale in the United States (at Syracuse, N. Y.) and is being developed in France, England and Norway. The importance of this division of gas technology is, therefore, readily grasped.

The gas mixture is required for the synthetic operation in a high state of purity. Inert gases, such as the argon group and methane, act as diluents and, in a circulatory system, necessitate a periodical blowing-off and loss of gas in order that the inert constituents do not accumulate beyond a working maximum. Water vapor, oxygen, carbon dioxide and carbon monoxide are catalyst poisons which when present continuously in concentrations of 0.01 to 0.1 per cent lower the efficiency of the synthesis quite markedly. Hydrogen sulphide and sulphur compounds are permanent catalyst poisons, cumulative in effect and eventually necessitating, if permitted to intrude, a renewal of the ammonia-making catalyst.

As a result of the large volume requirements of gas and the high purity essential to successful synthesis, the problem of preparation of the gas mixture is the most important in the cycle of operations from elementary nitrogen to fixed nitrogen product, whether this be ammonia, nitric acid, oxides of nitrogen, ammonium sulphate or other fertilizer compound. It has been computed[1] that the preparation of the compressed nitrogen-hydrogen mixture involves as much as 75 per cent of the total cost of the ammonia produced. The attention which has been paid in past discussions to the actual synthetic operation as compared to the gas preparation is out of all proportion to its relative importance and cost in the cycle of reactions. Recent literature abounds in discussion and reports of the ammonia-making processes. Scant attention has been paid to hydrogen and nitrogen technology.

A Review of Existing and Possible Processes

THE LIQUEFACTION PROCESS

The earliest synthetic ammonia plant, the Badische Co., at Oppau, operated on hydrogen obtained from water gas at 20 atmospheres pressure by liquefaction of the carbon monoxide in a liquefaction system of the Linde type, diagrammatically shown in Fig. 1. The nitrogen was obtained by fractionation of the liquid air, *h*, *i*, boiling under a partial vacuum, used to establish the low temperature (—205 deg. C.) necessary for the separation of the carbon monoxide from the hydrogen. The carbon monoxide was employed, after being vaporized, to drive a gas engine and thus produce the power requisite for compression of the water gas and of the air employed in the liquid air cooling system. Also the power requirements for a pressure water scrubber to remove carbon dioxide and an ammonia refrigeration system to remove water vapor were supplied from the same source.

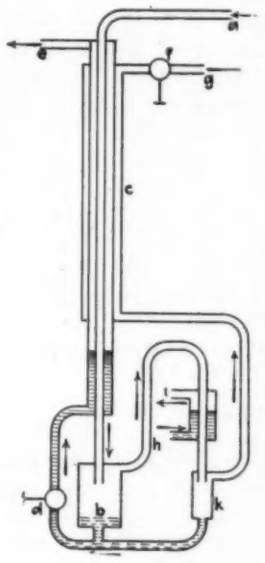


FIG. 1
LINDE LIQUEFACTION SYSTEM FOR HYDROGEN PURIFICATION

The normal purity of the hydrogen obtained corresponds closely to a gas of the following composition: $H_2 = 97$ to 97.5; $CO = 2$ to 1.7; $N_2 = 1$ to 0.85 per cent. Approximately 40 per cent by volume of the original water gas is received in this form from the liquefaction system. This gas, before use in ammonia synthesis, must be freed from the residual carbon monoxide, this being achieved of late by the Badische Co. by solution in ammoniacal cuprous formate under a pressure of 200 atmospheres. In the earlier stages of the process the carbon monoxide was absorbed at 200 atmospheres in hot caustic soda solution with the formation of alkali formates. Thus purified, the hydrogen residue contains less than 0.1 per cent carbon monoxide and admixed with the theoretical ratio of nitrogen from the liquefaction system was so used in the synthetic operation.

THE WATER GAS CATALYTIC PROCESS

The liquefaction process was discarded at Oppau in favor of the water gas catalytic process. In essentials this process consists of the oxidation at 500 deg. C. of the carbon monoxide in water gas by steam in the presence of a catalyst (oxide of iron), the reaction occurring being representable by the equation

$$\underset{\text{Water gas}}{H_2 + CO + H_2O} = 2H_2 + CO_2$$

The reaction is an equilibrium process and the final composition of the gas is dependent on the steam-water gas ratio, the temperature of operation and the efficiency of the catalyst. Furthermore, by using water gas admixed with semi-water gas (a gas containing the

*Paper read before the American Institute of Chemical Engineers, Buffalo, N. Y., June, 1922.

[1]Nitrogen Products Committee Report, British Munitions Inventions Department.

products of both air-blow and steam-run in the water gas process) a product may be obtained containing the bulk of the nitrogen required in the subsequent synthesis requiring only small amounts of nitrogen from the liquefaction of air for purposes of exact ratio adjustment. Details of plant, materials, engineering and operation of this process have already been discussed before this society[2], so it is not necessary to recapitulate such in this article. Fig. 2 shows the process diagrammatically. Emphasis only need be laid on the factor which accounted for the change from the liquefaction process to the catalytic process. The factor involved is the water gas:hydrogen ratio or, in other words, the ratio of fuel consumption to hydrogen yield in the two processes. Whereas somewhat less than 40 per cent by volume of the original water gas is received as hydrogen in the liquefaction process, the yield in the catalytic process, as can readily be seen from the previous equation, is equal theoretically to that of the water gas consumed. In actual practice it is possible to receive unit volume of hydrogen by the expenditure of 1.25 volumes of water gas. The fuel bill, therefore, should be just one-half that obtaining in the liquefaction process. The purity of the product corresponds approximately with that from the liquefaction process, so that no advantages accrue to the catalytic process in that respect.

The Steam-Iron Process

The industry of oil hydrogenation for the production of soap stock and of edible fats has made but little use of hydrogen from either of these two sources. This should, in the main, be attributed to the nitrogen and carbon monoxide present in the hydrogen so obtained. In ammonia synthesis nitrogen is a reactant; in oil hardening it is a troublesome inert, present to the extent of several per cent, depending on the nitrogen content of the original water gas. Until recently the methods technically developed for the removal of 2 to 4 per cent carbon monoxide have been operated at 100 atmospheres pressure or upward, generally at the working pressure of the ammonia synthesis operation. Such pressures are entirely unnecessary in technical hydrogenation and therefore involve unnecessary compression costs.

Operation of the carbon monoxide purification processes at lower pressures is less satisfactory. Hence the additional objections to these two processes of hydrogen manufacture for hydrogenation work. The chemical method of hydrogen production for the oil-hardening industry has therefore been what is variously known as the steam-iron process or the iron-contact process. It consists in the production of hydrogen by the interaction of steam and iron at temperatures in the neighborhood of 700 deg. C. The contact mass is regenerated by reduction of the iron oxide in a stream of a suitable reducing gas, normally water gas, whereupon the cycle of operations may be repeated. The hydrogen thus produced is easily obtained in a high state of purity. The gas can leave the producing system containing less than 1 per cent impurity, of which the bulk is carbon dioxide, easily removable, with but small fractions of 1 per cent of carbon monoxide and nitrogen. With special precautions these impurities can be diminished still further, even in the production process. As will be shown, also, newer methods of purification are capable of easy and cheap removal of carbon monoxide not in excess of 1 per cent, even in the presence of several per cent of carbon dioxide. The steam-iron process, therefore, without special refinement, is capable of yielding hydrogen of a purity sufficient for ammonia synthesis purposes.

The non-utilization of the steam-iron process in nitrogen fixation work is to be attributed to three main factors, (*a*) the fuel cost, (*b*) the intermittency of the process and consequent high operating cost and (*c*) the high cost of plant and of renewal of plant. These factors merit detailed consideration.

The fuel cost is high, since in the best practice hitherto attained in this process at least 2.5 volumes of water gas have been normally consumed in the production of 1 volume of hydrogen. The process at present, as regards fuel cost, ranks on a parity with the liquefaction process and is considerably inferior to the catalytic process. I have attempted elsewhere[3] to show that the high ratio of water gas consumed to hydrogen produced was to be attributed to the equilibrium relationships in the essential reactions of the process in both steaming and reducing phases. These reactions may be formulated by means of the following reversible equations:

$$3Fe + 3H_2O = 3FeO + 3H_2$$
$$3FeO + H_2O = Fe_3O_4 + H_2$$
$$3Fe + 3CO_2 = 3FeO + 3CO$$
$$3FeO + CO_2 = Fe_3O_4 + CO$$

Accepting the most recent and reliable data obtained by a single investigator covering these several equilibria[4], I have computed the following tables of hydrogen and carbon monoxide consumption at equilibrium and the consequent water gas:hydrogen ratio deduced upon the assumption of such equilibrium conditions in the reducing phase.

Fe_3O_4-FeO Reaction

Temperature	Per Cent H_2 Consumed	Per Cent CO Consumed	Water Gas:H_2
570	27	47	2.7
650	41	55	2.1
750	58	67.5	1.6
850	75	75	1.33

FeO-Fe Reaction

Temperature	Per Cent H_2 Consumed	Per Cent CO Consumed	Water Gas:H_2
570	27	47	2.70
650	30	44	2.70
750	35	40	2.66
850	38	36	2.70

From these figures it is evident that, assuming equilibrium, only by operating at high temperatures and on the Fe_3O_4-FeO cycle alone, a ratio of water gas consumed to hydrogen produced equal to that yielded by the water gas catalytic process would be attained. The disadvantage of working on the Fe_3O_4-FeO cycle is made apparent by referring to the preceding equations, whence it is clear that only one-quarter of the output per unit of contact mass is obtained as compared with that yielded by the complete Fe_3O_4-Fe cycle.

Peculiar Conditions at the Start of Steaming and Reducing Periods

Recent investigations by Richardson, Vibrans and Bell[5] on actual plant operations as well as in laboratory trials have shown that in the first minutes of either the reducing phase or alternatively of the steaming period the conversion of the reacting gases is greater than that calculable from the above equilibrium figures or from

[2]Tour, *Chem. & Met.*, vol. 26, p. 245, *Trans.*, Am. Inst. Chem. Eng., vol. 13, Part II, p. 273.

[3]"Industrial Hydrogen," A.C.S. Monograph; Chem. Catalog Co., 1921.

[4]Chadron, *Annales de Chemie*, 1921, vol. 16, p. 221.

[5]A.C.S. spring meeting, Birmingham, Ala., 1922.

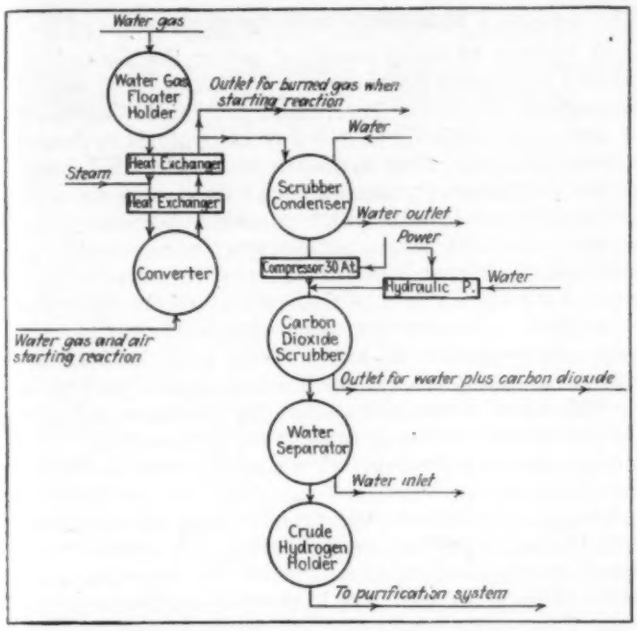


FIG. 2—FLOW SHEET OF THE WATER GAS-CATALYTIC PROCESS

any such data to which a degree of reliability can be assigned. It was found that the oxidation of the water gas to carbon dioxide and steam was much more nearly quantitative than the equilibrium figures would suggest. The implication of these results is that under conditions such as prevail in the first moments of the respective reactions it should be possible to obtain almost unit volume of hydrogen by the expenditure of a unit volume of water gas. For every molecule of water gas oxidized in the reducing phase a molecule of hydrogen accrues in the steaming phase. With such a water gas: hydrogen ratio, the steam-iron process is immediately on a parity with the catalytic process as regards fuel consumption. In addition, the gas purity and ease of purification of such hydrogen give to it a measure of importance worthy of serious consideration.

The explanation of the divergence between experimental results and theoretical equilibrium data is deserving of attention. At the moment, I incline to the view that complete consumption of the hydrogen and carbon monoxide of the water gas is approached in the early moments of the run, because in those moments the experimental conditions are such that the criteria for equilibria are not fulfilled. In any of the reactions involved as, for example,

$$Fe_3O_4 + CO = 3FeO + CO_2$$

it may readily be shown that, for a definite equilibrium ratio between the two gases, it is demanded by the phase rule that *two* solid phases shall be present. At the outset of a run this condition is apparently not fulfilled; the gas in its travel through the retort system is then continually in contact with only one solid phase. At the beginning of the reducing phase this is the ferrous-ferric oxide Fe_3O_4. Only when the two solid phases Fe_3O_4 and FeO are present should the equilibrium be established. With only Fe_3O_4 present, oxidation of the carbon monoxide continues until either the carbon monoxide is completely converted to the dioxide or reduction of the ore is carried to the stage throughout the contact mass at which equilibrium relationships are possible.

The direction which development work in the steam-iron process should take is, therefore, obvious. Work should be directed toward devising working conditions such that the circumstances prevailing in the earlier moments of the process as at present conducted could be continuously maintained. The reorganization of the steam-iron process which such a study would involve would undoubtedly bring with it many improvements in the chemical engineering aspects of this industrial process, which hitherto has been left far too much in the hands of the empiricist, without attention from scientifically trained men. Diagrams of the multiple and single retort units as now operated are shown in Figures 3 and 4 respectively. In such a reorganization, the intermittency of the process, which is quite unnecessary, could be eliminated. Operating costs should thereby be lowered. Cost of plant and of plant renewal would also receive attention. It is not too much to hope that the steam-iron process technologist would profit, in respect to plant and plant renewal, by the experiences of others in the matter of heat-resisting alloys and the economies resulting from their substitution for cast iron.

Given a steam-iron process so modified as to give a fuel: hydrogen ratio comparable with that now attainable in the water gas catalytic process, the advantages would all be with the steam-iron process. The expensive

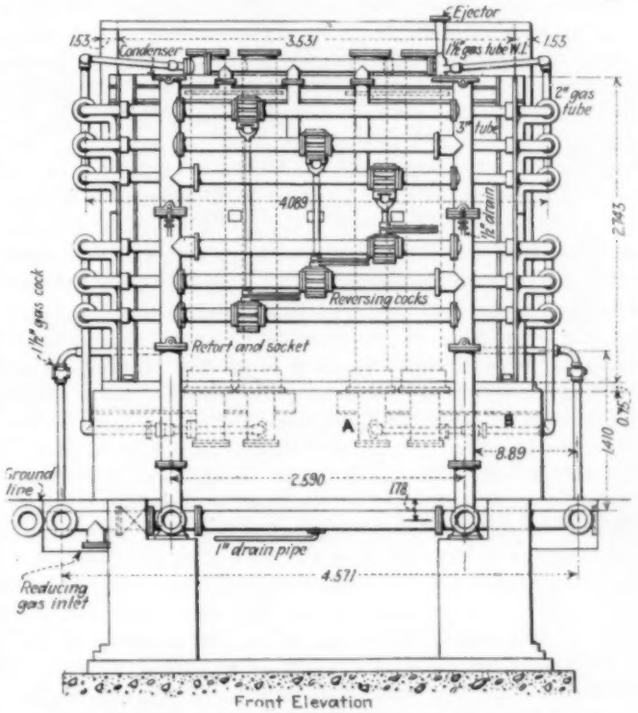


FIG. 3—MULTIPLE UNIT RETORT FOR STEAM-IRON PROCESS FOR HYDROGEN (From *Engineering*)

items in the water gas catalytic process are the purification processes. The removal of upward of 30 per cent carbon dioxide and a residual 2 to 4 per cent carbon monoxide is attained only at an expense somewhat greater than that involved in the production of the hydrogen-rich gas containing these impurities. Steam-iron process hydrogen, on the other hand, contains but 2 to 4 per cent total impurities, of which 1 to 2 per cent is carbon dioxide, 0.1 to 0.5 per cent carbon monoxide and residual sulphur compounds and nitrogen. The Harger-Terry process[6] of preferential combustion of carbon monoxide in hydrogen has solved the problem of purification of steam-iron process hydrogen satisfac-

[6]Brit. Pat. 127,609 (1917); U. S. Pat. 1,366,176.

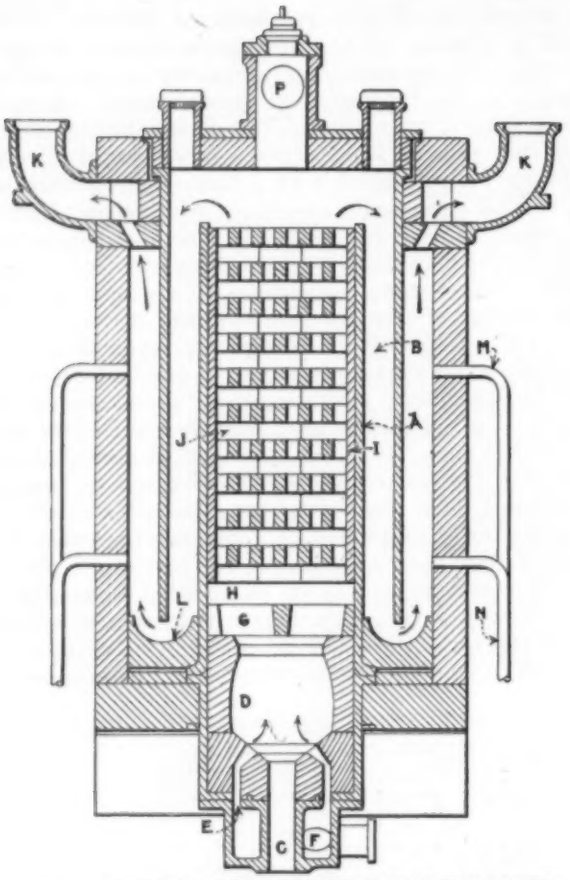


FIG. 4—SINGLE UNIT RETORT FOR STEAM-IRON PROCESS FOR HYDROGEN

torily and cheaply. It has now been operated successfully on a large technical scale in the United States. The process as now operated is applied to the gas leaving the iron oxide box system used to remove hydrogen sulphide from the gas issuing from the retorts. The sulphur-free gas so obtained is admixed with a small percentage of steam and oxygen sufficient to burn twice the theoretical quantity of carbon monoxide present. The mixture is raised to 200 deg. C. by a heat exchanger system and passed over a modified iron oxide catalyst containing suitable promoters at a temperature within the interval 200 to 250 deg. C. In actual practice, on a technical scale a gas containing 0.5 per cent carbon monoxide has been purified so that less than 0.03 per cent of this impurity is left after the passage of the gas through the catalyst system. The carbon dioxide so produced, together with that originally present in the gases leaving the steam-iron process retorts, may be removed in the normal manner. In American practice this usually consists in scrubbing with caustic soda solution in coke-filled towers. In England lime boxes have been mainly used. The gases leaving such a purification system are practically exclusively hydrogen, the impurities, with the exception of nitrogen (which also can, if desired, be kept quite low in concentration), never exceeding in such case more than a small fraction of 0.01 per cent. The product is therefore eminently suitable for ammonia synthesis purposes. A contrast of the purification process involved, carried out wholly at atmospheric pressure, at slight cost, with simple apparatus, with that involved with water gas catalytic process hydrogen, at once establishes its worth. Therefore, the steam-iron process still deserves the most thorough attention of the hydrogen technologist.

Electrolytic Hydrogen

At sources of cheap electrical power the electrolytic method of generating the gas will always be primarily considered. It is for this reason that in developments of ammonia synthesis in Norway electrolytic hydrogen is contemplated. This hydrogen is so pure that many of the problems of ammonia catalysis, bound up with the impurities in chemically prepared hydrogen, disappear. In such places as Norway, power costs are relatively less important. Plant cost, however, represents still quite an item in the economy of the hydrogen production. In America, even the electrical energy from water power is more costly than in Norway. Hence in America, even with water power, and more so with steam power, the electrolytic hydrogen industry for ammonia synthesis must meet competition from other types of hydrogen in both power costs and plant costs.

The electrolytic hydrogen problem must be considered as a hydrogen problem, as estimates of hydrogen costs based upon assumptions of a market for byproduct oxygen will be fictitious. The byproduct oxygen resulting from electrolytic production of the hydrogen will far exceed the extreme *present* oxygen-consuming capacity of any reasonable radius of industrial territory. It is necessary therefore to assume the oxygen wasted to the atmosphere.

The interdependence and variability of power charge, output and capital cost of an electrolytic plant make a complete analysis of the problem diffcult. An excellent effort in this direction has recently been made by Allan[1] based upon the use of off-peak power and of cells with higher than usual amperage. Allan predicates that in many hydro-electric plants off-peak power "could be sold for as low as one mill per kilowatt-hour and probably would not exceed 2.5 mills per kilowatt-hour under the most unfavorable conditions." For successful competition in ammonia synthesis the power costs must be within the above maximum.

The tendency toward high-amperage cells for higher operating efficiency at lower costs as indicated by Allan will certainly be followed in successful efforts to produce hydrogen for ammonia synthesis by the electrolytic method. Indeed it may be stated that the figure quoted by Allan of 1,350 amperes as the normal current capacity of his cell will probably be greatly exceeded. During the war period experiments in the building of 10,000-ampere units were successfully engineered. It was found that a unit of such size could be operated with a voltage drop of 2.5 volts. With an overload, giving a cell operating at 15,000 amperes, a potential of 3 volts per unit was required. Wide flexibility of operating range with minimum variation in working efficiency will constitute an important factor in the design of such cells. It has been stated that the initial cost of such high amperage cells is not at all proportionate to that of the number of 500- to 1,000-ampere cells required to yield the same gas output. Hence a proportionate diminution in initial cost and therefore in interest, depreciation, wear and tear should result. Initiation of electrolytic manufacture of hydrogen for ammonia synthesis will constitute a bold experiment—if successful it will lead to industrial developments far outside the range of ammonia synthesis alone, by reason of the simultaneous oxygen production, uses for which would inevitably be sought.

[1] *Trans.*, Am. Elect. Soc., Baltimore, Md., May, 1922. Preprint No. 10.

The Problem of Carboy Closure

Review of the Manufacturing Chemists' Association Report on the Use of Neck Grinding Machines for Carboy Closure

AS PART of a comprehensive program of study in connection with the difficult problem of carboy closure, a sub-committee of the Manufacturing Chemists' Association of the United States has submitted a report entitled "Carboy Neck Grinding Machines and Their Application to Carboy Closure."

In their preliminary study they found it extremely difficult to provide an efficient and suitable closure for carboys with chipped or cracked necks. Many materials have been used to seal the closure, such as plaster of paris, Pecora cement and many special mixtures, but all were found to be unsatisfactory in some respects. It therefore became necessary to eliminate if possible the cracked or chipped necks in carboys. During a general discussion of the subject it was suggested that it might be possible to grind down the necks that were chipped or cracked. Mr. Gayner, of the Gayner Glass Works, said that such a machine was in use in his works, but that it was scarcely sufficiently developed for ordinary use. He nevertheless offered the use of his ideas and experience.

Experimental Work by Merrimac Chemical Co.

Mr. Callahan, of the Merrimac Chemical Co., a member of the sub-committee, undertook an investigation of the proposal. He constructed preliminary machines and after the expenditure of considerable time and money brought the machine to a point of efficiency where it can be considered commercially practicable. A side elevation of the machine finally developed at the Merrimac Chemical Co. is shown in Fig. 1. This diagram reveals the essential principle—that of supporting the carboys on a horizontal carriage and bringing them in contact with rotating cast-iron disks. Two carboys may be ground at the same time by an unskilled laborer and it is reported that the power consumed is relatively small.

Grinding off the chipped neck gives a smooth surface on which to seat a gasket and should eliminate leakages that have been due to chipped or cracked necks. There is a distinct saving in the expense of effecting good closure, because the quantity of plaster of paris is very much diminished. A cleaner and better closure is also obtained.

Machine Eliminates Buyer-Seller Disputes

A factor not to be neglected in connection with the use of this machine is the elimination of all controversy as to the chipping or breaking of the necks of carboys. Frequently a distinctly unpleasant controversy is the result of shipping out carboys with chipped necks. Consumers often claim full credit for returning carboys in good condition when the necks are chipped and the producer is very frequently hard put to know whether he had chipped the carboy necks or whether the consumer actually was responsible. This leads to compromises which are not satisfactory to either side. Under the new régime, if necks were all sent out smooth, then any return carboys which are chipped must be due to improper treatment by the customer or the transportation company.

Several other points about the operation of the machine are worthy of note. In the first place, the carriage on which the carboy rests is given a cross-motion so that the wear is comparatively even over the surface of the grinding disk. In addition the longitudinal movement of the carriage is automatic, which greatly facilitates operating. Finally, the actual grinding is done with a cast-iron disk which is fed with a mixture of sand, emery and water directed on to the disk at the point of contact with the carboy. It is also distinctly worth noting that the machine will grind down the neck of a carboy at the average rate of half an inch in 5 minutes and at an average cost of less than 10 cents per carboy.

Formal Recommendations of the Committee

The following series of recommendations were adopted by the committee and submitted as a preliminary to the more complete report on carboy closure:

1. That glass carboys used for the shipment of corrosive liquids must have an even surface around the

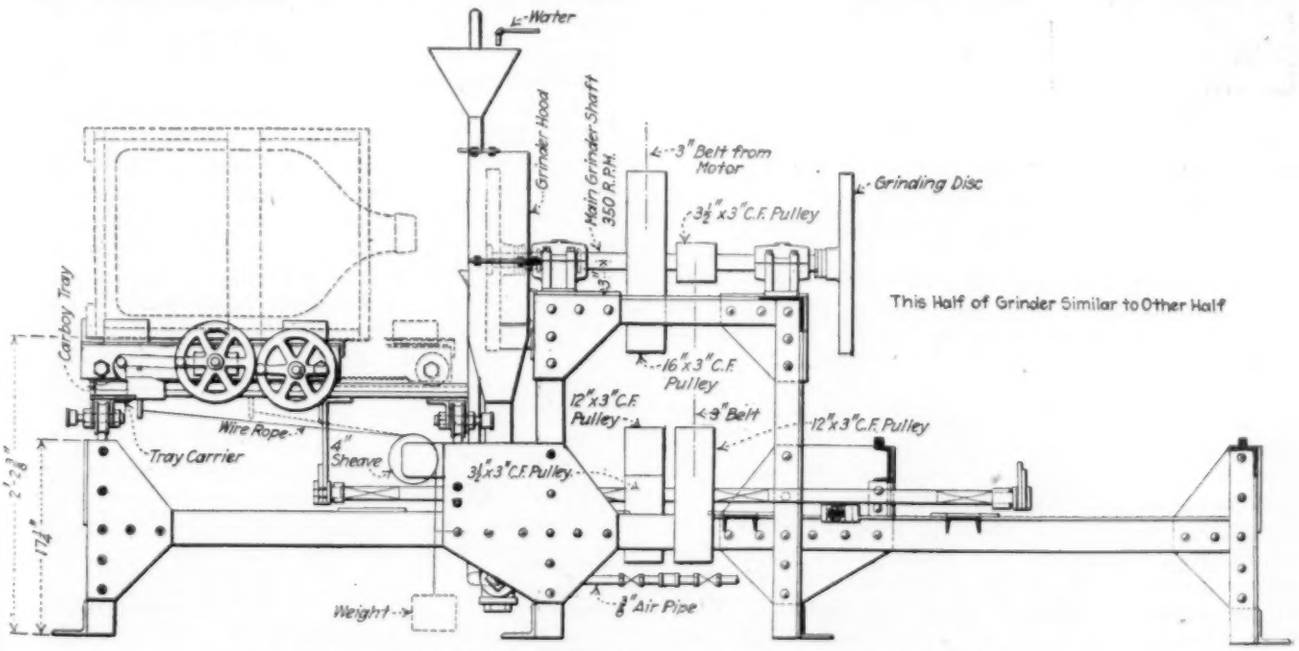


FIG. 1—SIDE ELEVATION OF CARBOY NECK GRINDING MACHINE

mouth on which to seat the gasket; this surface must be at least ¼ inch in width for carboys of 7 to 13 gal. capacity and at least ⅛ inch in width for carboys of less than 7 gal. capacity.

2. That immediate action be taken to advise all users of carboys as to the undesirability of using carboys with chipped and cracked necks, pointing out the practicability of reconditioning such carboys and supplying them with blueprints of the carboy neck grinding machine as developed up to the present time.

3. That the Bureau of Explosives be requested to take appropriate action at some future date such that all concerned will have ample opportunity to prepare themselves for the change, to make the provisions of recommendation 1 obligatory and effective throughout the United States and Canada.

To anyone who has dealt with the problem of carboy closure, this report will appeal as being statesmanlike and progressive. The Manufacturing Chemists' Association is to be commended for furthering such work.

Defects in Baked Enamels

Peculiar Lines on the Otherwise Bright Surface Prove to Be Scratches Caused by a Brass Nozzle—Eliminated by Using an Iron Nozzle

BY G. W. WALKER
Hupp Motor Car Corporation

CERTAIN peculiar defects having appeared in enameled automobile fenders, an investigation was made to determine, if possible, the cause of these defects. Not all the fenders in the same lot showed the defects —which consisted of lines, some long, others short, in the otherwise bright and uniform surface of the enamel. Along these lines the enamel was "dead"—that is, without luster—and had an appearance as if a thread had been drawn over the wet enamel. These defects appeared through two coats of enamel when baked on.

When the enamel was carefully removed from such lines by use of a solvent, no defect could be found in the metal beneath even on magnification. It was suggested that the metal was "porous," but photomicrographs failed to reveal any pores.

It was noted that these defects generally appeared on certain parts of the fenders and more generally near the crown.

On following through the various operations preparatory to enameling, it was found that an air hose with a brass nozzle was used in the final cleaning operations just previous to enameling. At times the workman would touch the fender with this nozzle, sometimes drawing it along the surface. To test the matter, a fender was selected and the nozzle was drawn several times across the surface. All of these lines appeared in the finished fender, showing through two coats of enamel, with the same appearance as before noted.

The same results were obtained in laboratory experiments. When the corner of a piece of brass was drawn with comparatively light pressure across a piece of sheet metal, which was afterward enameled and baked, the lines appeared through the enamel.

It would appear that small particles of brass worn off by abrasion against the harder sheet metal were sufficient to cause the above defects, but a magnification of 150 diameters failed to reveal any particles. However, when an iron nozzle was substituted for the brass one, the above defects disappeared.

Manufacture of Explosives in 1921

The Department of Commerce announces that the reports made to the Bureau of the Census show a decrease in the activities of the establishments engaged primarily in the manufacture of explosives during 1921 as compared with the year 1919. The total value of products amounted to $59,174,600 in 1921, and to $92,474,800 in 1919, a decrease of 36 per cent. Of the 109 establishments reported for 1921, 24 were located in Pennsylvania, 10 in Ohio, 9 in Oklahoma, 8 in Illinois, 7 in New Jersey, 6 in West Virginia, 5 in Kentucky, 5 in Missouri, 4 in Kansas, 4 in Texas, 3 in California, 3 in New York, 2 each in Alabama, Colorado, Indiana, Michigan, Tennessee, Washington and Wisconsin and 1 each in Arkansas, Iowa, Massachusetts, Minnesota, Montana, Utah and Wyoming. Of the establishments reporting in 1919, 11 were idle or out of business in 1921, 2 new plants being reported for the latter year.

The statistics for 1921 and 1919 are summarized in the following statement. The figures for 1921 are preliminary and subject to such change or correction as may be necessary from a further examination of the original reports.

	1921	1919	Per Cent of Decrease*
Number of establishments	109	118	7.6
Persons engaged	7,926	15,429	48.6
Proprietors or firm members	22	28	...
Salaried employees	2,426	6,152	60.6
Wage earners (average number)	4,478	9,249	51.6
Salaries and wages	$13,610,200	$25,749,200	47.1
Salaries	7,000,000	13,244,200	47.1
Wages	6,610,200	12,505,000	47.1
Paid for contract work	...	30,500	...
Cost of materials	30,644,300	45,911,000	33.3
Value of products	59,174,600	92,474,800	36.0
Value added by manufacture†	28,530,300	46,563,800	38.7

* Percentage omitted where base is less than 100.
† Value of products less cost of materials.

Detail statistics of production for the years 1921 and 1919 are given in the following table:

	1921	1919	Per Cent of Decrease*
Products, total value	$59,174,600	$92,474,800	36.0
Explosives:			
Lb.	407,374,400	506,138,800	19.5
Value	$55,753,800	$85,668,200	34.9
Dynamite:			
Number of establishments	26	27	...
Lb.	167,258,300	212,529,700	21.3
Value	$28,457,300	$37,230,700	23.6
Permissible explosives:			
Number of establishments	19	15	...
Lb.	36,819,200	30,622,900	†20.2
Value	$6,379,000	$5,499,200	†16.0
Blasting powder:			
Number of establishments	42	44	...
Kegs (25 lb.)	7,340,768	7,406,991	0.9
Value	$12,544,900	$12,168,500	†3.1
Gunpowder, black:			
Number of establishments	5	7	...
Lb.	990,700	11,730,100	91.6
Value	$227,400	$2,096,600	89.2
Nitroglycerine:			
Total production, lb.	45,855,400	56,361,200	18.6
Sold as such:			
Lb.	172,600	714,700	75.8
Value	$160,700	$301,900	46.8
Made and consumed in shooting wells, (included in totals):			
Number of establishments	39	...	...
Lb.	3,418,700	7,621,900	55.1
Amount received for contract work, shooting wells	$3,234,400	$3,434,800	5.8
Made and consumed in the manufacture of dynamite:			
Lb.	42,264,100	48,024,600	12.0
Other explosives, in order of value, 1921, — smokeless powder, nitrostarch, fuse powder:			
Lb.	15,195,700	57,744,700	73.7
Value	$4,750,100	$24,936,600	81.0
All other products	$3,420,800	$6,806,600	49.8

* Percentages omitted where base is less than 100.
† Increase.

Accelerated Reactions in Pulsating Gaseous Currents

Utilization of Pulsations and Vibrations of Appropriate Amplitude to Accelerate Physical Interchanges and Chemical Reactions Between Gases and Vapors in Checkerworks, Labyrinths, or Piled-up Solids

By Jules Deschamps* and J. F. Shadgen†

MECHANICAL improvements in the design and construction of rotating machines are enabling them gradually to displace similar devices having reciprocating movement. This is particularly true of pumps used for moving liquids or gases. Turbo pumps are supplanting plunger pumps everywhere and fan blowers are becoming more popular than compressors. Ejectors and injectors based on continuous kinetic expansion of gases are even more favored for the entire absence of moving parts. Uniformity of flow has always been considered a desideratum, and gas currents of constant intensity are preferred in all apparatus for blowing or circulation purposes and even in all problems of combustion, condensation, cooling and drying.

The main advantages of all rotary machines are simplicity and cheapness of construction. This is mostly due to the fact that no account need be taken of complications or forces due to inertia. But the efficiency of the rotary machines is usually lower than those built for alternating movement.

It is interesting to observe that nature, with its many complex machines, seldom uses continuous movements. Most physical and chemical actions of life are reciprocating or pulsating, from the walk of the animals to the flight of the birds and insects, from the respiration of the lungs to the circulation of blood in veins and arteries.

Use Continuous Flow for Transportation of Fluids

For the transportation of fluids in pipes there is no doubt that uniformity of flow is quite desirable. No one can contradict the superior advantage of a constant difference in pressure when liquids are to be moved. But if fluids when flowing through chambers are put in contact with other bodies in order to react physically or chemically or to be subjected to any transformation during the circulation, the optimum conditions may be altogether different.

In studying most engineering problems, average results have been derived from the tests of working machines and the solution of new problems based on simplified hypothetical considerations. Consequently the calculated results differ from the actualities. In order that we may approach the test results more closely, the designer uses many coefficients in his empirical equations, paying due regard to the peculiarities of each problem. This is especially true of working formulas used in computing the hydraulics of rivers and streams. Furthermore, when studying a gas within a given space, it is commonly accepted that within that volume both pressure and temperature are uniform at all points. This does not correspond to the conditions really existing; it is merely a gross approximation. For if the theory of probabilities is applied, the proportions of molecules having the same velocity can be calculated and the result leads to the inevitable conclusion that both temperatures and pressures differ considerably from one point to another. Considering that a lack of uniformity exists in simple gas analyses, it is easily understood that outside influences such as light waves or sound vibrations can modify the direct application of the law of Maxwell and consequently the whole equilibrium in the mass, as well as the reactions possible between its constituent elements or between them and other bodies at their natural contacts.

Let us consider some of the effects that can be produced by vibrations of about the velocity and amplitude of sound waves and also by pulsations of more moderate velocity. It is necessary to distinguish between these two types of periodic disturbances. The slow pulsations (produced by an alternative movement of a piston and of the order of one per second) create an increase of pressure, followed shortly afterward by a reduction, acting upon a considerable portion of the gas upon which they are impressed. On the other hand, the quick vibrations, measured by hundreds per second, change the relative distance between neighboring points sometimes no farther apart than the distance between adjacent molecules. Evidently no absolute line of separation exists between the two types of vibrations. Study of one type explains the other just as slow motion pictures illustrate the nature of rapid movements.

Take for instance a cooling or absorption tower filled with inert solids piled up regularly or irregularly. A fine rain of liquid sprays this packing material and drops toward the bottom. A gas or vapor rises from the bottom to the top. Contact between ascending gas and descending spray may produce physical effects such as cooling or solution, or on the other hand a chemical reaction may ensue.

Continuous Flow Produces "Dead Spaces" in Reactors

It is a common observation that there is an economical limit to the height of such towers beyond which the results are not increased in proportion to the expense involved. In other words, two towers of half the height will give a better efficiency than one very tall tower. This is explained by the fact that the descending liquid gathers in large drops after having passed through several layers of fillings no matter how fine and uniform is the original spray. These drops have a tendency to coalesce and the liquid finally streams along certain preferred channels, leaving large areas "dead." To counteract these conditions the tower packing would be divided in successive layers with a free space between them; the shape of the checkerwork has been carefully studied as well as the method of

*Paris, France.
†New York City.

piling. The results of all these palliatives has been disappointing, since the liquid eventually flows over the surfaces of the checkerwork while the gases ascend in the voids offering the least resistance. Hence bad contact and poor efficiencies result.

When a vapor or a gas is drawn through such tower by a constant difference in pressure, a certain equilibrium is established in the flow. All the gas does not rise from the bottom to the top with the same velocity through the various passages of the same horizontal cross-section, because the resistance due to friction on the walls or due to the downpouring liquid differs at these various channels, while the difference of pressure at top and bottom remains the same. Another cause responsible for variable speed in the various channels is the difference in effective cross-sectional area at various heights due to the shape of the piled-up bodies which in turn inevitably creates whirls and eddies.

If we consider a channel such as in Fig. 1 through which passes a stream of gas, it is apparent that the velocity in the sections *x*, *y* and *z* is different from those in the smaller sections *m*, *n*, *o* and *p*. It is doubtful that full expansion follows each restricted area and the equilibrium of flow will probably correspond to the dotted lines, thus illustrating that considerable portions of the contact surfaces are not at all well fed.

Again, consider a pile of irregular solids such as shown in Fig. 2. Two channels, 1-2-3, and 4-5-6 will have quite different average velocity. However, the pressure will be approximately the same at various heights. Consequently there will be little or no flow in the cross-channels 7, 8 or 9, particularly if they connect sections of a different area. Flow channels and surrounding eddies will form and the surfaces along cross-channels will be dead areas with small effect.

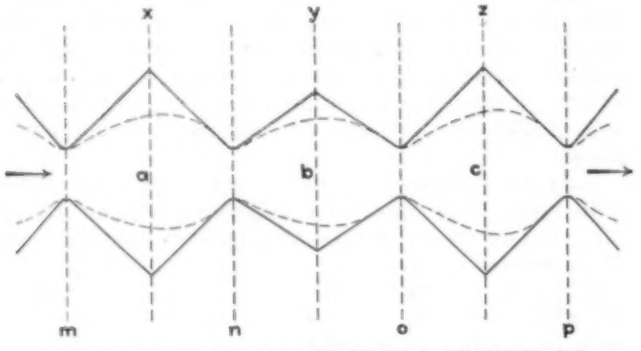


FIG. 1—FLOW OF GAS THROUGH A CHANNEL OF VARYING CROSS-SECTION

Analyze now in a similar way the phenomena produced by a variation of pressure, whether periodic or not, between the top and the bottom of the pile. By suddenly producing a greater difference in pressure any existing balance in the flow channels is overthrown. Channel 4-5-6 has fewer restrictions; therefore the pressure increase will be transmitted through it more easily than in channel 1-2-3. Consequently there will be produced a slight difference in pressure at the points 1 and 4, 2 and 5, and 3 and 6, which in turn will promote cross-currents sweeping through the transverse ways and supply them with fresh gas for reaction or absorption. Further, these lateral flows will also create whirls upon meeting the upward flow. If before these effects die out we suddenly produce a decrease in pressure, the same results will be created in the reverse direction. It follows that no real equilibrium can exist if the speed and amplitude of vibration is correctly chosen.

Every increase in pressure will force the gas into the tightest corners and at the opposite crest of the pulsation wave the products of the reaction will stream out of these dense parts. As these corners and labyrinths are the most drenched by a descending liquid or are those offering the largest surface of contact, the ultimate result will unquestionably be a much higher efficiency in the tower.

This analysis applies to cooling, volatilizing, concentrating or distilling operations—purely physical operations—as well as those chemical phenomena where gases or vapors react with each other in the presence of inert solids. If the gases or vapors passing through the shaft react chemically with the solids themselves (as in gas producers or blast furnaces), further consideration will indicate that the effects will be very similar. In such apparatus a continuous injection at constant pressure will create channels of least resistance through which the most of the gas will stream. But as the gases attack the solids in proportion to their contact surfaces, any restricted area will be widened very quickly. Lateral passages will then be even more ineffective than indicated in the diagram (Fig. 2); furthermore, the vertical channels may become coated by ashes or slags, offering strong resistance to further attack. If these chimneys or channels reach the top of the fuel bed in a gas producer, the air passes through and burns some of the gas already formed.

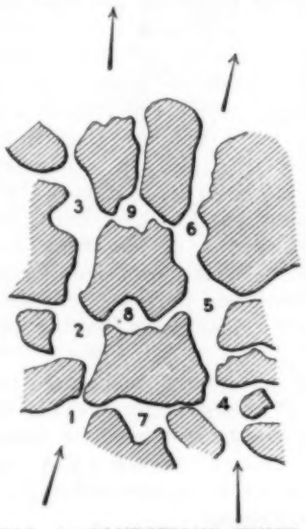


FIG. 2—CONDITIONS EXISTING IN A PILE OF IRREGULAR MATERIAL

To prevent this trouble these channels must collapse. Many recent improvements in producer design aim to favor these collapses by mechanical means (i.e., by stirring or plowing). If air streams up one or more of these large chimneys and if the piled-up solids between these channels are attacked to but a small degree, the zone of combustion is displaced, a poor gas with too much carbon dioxide is generated and coal is lost unburned in the ashes. Widespread disturbances in a blast furnace follow like causes. In order to avoid such bad effects, operators are forced to reduce the rate of blowing with consequent loss of production.

Pulsations in the air supply would force the air to penetrate into the whole mass of piled-up solids. Gases formed in the producer, such as CO and H, consequently cannot stay in the pockets, and corners and channels are not so easily produced. The solids are attacked from all sides simultaneously and the pile collapses by natural shrinkage. Hence producers will operate more regularly and with greater output when operating with pulsating current or blast.

If the solids to be attacked are of a porous nature, gas pulsations will produce additional advantages, since reactions inside the pores will be stimulated. In water-gas producers, for instance, steam is blown through hot

coke periodically. It can be reasonably expected that a pulsating jet will result in more rapid generation of hydrogen, and the correct object may be obtained by a steam injection of shorter duration.

A mixture of steam and air is injected into ordinary producers generating heating gas. By a pulsating current one may send the steam-laden air into the mass of hot coal at various pressures or, better, inject successively a current of dry air and a jet of air supersaturated with steam and give to these impulses variable durations. This latter method of operation will give the steam a better chance to act on the fuel superheated by the injection of dry air. It follows that periodic changes of pressure also create periodic variations of temperature. One may inject gas or vapor by different pulsations into many other industrial processes. If several constituents enter into the reaction, they can act successively or in variable proportions at periodic intervals. Favorable results can be foreseen for pulsations of relatively high frequency, even if the gases react on each other in the presence of catalytic solids.

In large industrial apparatus where gas is injected through several openings or tuyeres, such as an iron blast furnace, variation of pressure inside the mass and a change in the upward paths taken by the blast can be facilitated by dampening the tuyeres for intervals in rotation, thus producing an alternating movement in the gas in the reacting zones. This device may be superimposed on one which actually varies the pressure on the blast main.

Scope of the Process

It is obvious that each industrial application will require individual study to fix the amplitude and frequency of the pulsation promising best results. Attention may, however, be drawn to the fact that in several industries (such as when cooling of coke-oven gas) a sequence of towers is utilized. Pulsating devices attached to each tower may be operated in synchronism or not as seems desirable. By proper regulation, the towers can be operated like a set of lungs that are filled and emptied periodically.

An enormous field is thus laid open and remarkable combinations are made possible. Preliminary investigations on a commercial scale promise most interesting results. Pulsations of moderately long duration have been studied already. Rapid vibrations cannot be transmitted through a checkerwork because the height of an unobstructed channel must be in proportion to the period. In an ordinary tower, short vibrations create mutual interferences and the action is annulled when pressure changes move at different speed through various pathways. Pulsations must be of a duration to produce pressure differences throughout the entire mass; their frequency has to be in proportion to the time required by the gas to flow through the entire checkerwork. That is why the pulsations in gas producers should not be restricted to the steam alone, as the quantity of vapor blown is small as compared to the quantity of air entering the apparatus. Therefore a steam injection would be of too short duration to be of value.

To summarize, it may be said that the nature of the pulsations desired depends upon the effective height of the checkerwork or filling, upon the dimensions of the solids or bricks, and upon the speed of reaction characteristic to the chemical and physical phenomena involved.

The Story of the Production and Uses of Ductile Tantalum*

Within the Past Year Metallic Tantalum Has Been Produced Which Is Ductile and Malleable—Its Production Described and Its Possible Uses Forecast

By Clarence W. Balke
Fansteel Products Co., Inc.

In THE year 1801 Hatchett discovered the oxide of a new metal in a black mineral which he obtained from the British Museum. He named the metal columbium and the mineral columbite, because the mineral originally came from Massachusetts. A year later Eckeberg made a similar discovery while working with some new minerals from Sweden, and he named the new metal which he discovered tantalum. Subsequently a number of other investigators announced the discovery of new metals in tantalum- and columbium-bearing ores which were all shown to be mixtures of these two, and in 1866 Marignac developed his classical method for their separation, which depends upon the difference in solubility of their double fluorides with potassium.

The first mention of tantalum in the metallic form is that obtained by Berzelius. In 1824 he obtained a very impure product containing not over 60 per cent of metal and having a specific gravity of 10 by reducing potassium tantalum fluoride with potassium. In 1902 Moissan produced a very hard and brittle form of tantalum high in carbon and having a specific gravity of about 12.8. In 1903 Dr. W. von Bolton, working in Germany, developed a process for the production of tantalum of sufficient purity to make it possible to produce drawn filament wire for incandescent lamps, and during the years 1905 to 1911 probably over one hundred million of these lamps were produced. This material as a filament wire was then replaced by tungsten.

About twenty years ago the writer became interested in these elements and devoted a number of years to the study of their various compounds and to the determination of their atomic weights. More recently, believing in the commercial value of this metal, an investigation was begun with the idea of producing the metal in commercial quantities. During the present year this investigation was brought to a successful conclusion and it is now possible to produce tantalum characterized by high purity and capable of being worked into sheet, rod or wire.

Occurrence of Tantalum

The elements tantalum and columbium are usually found associated with each other in their ores. The most important minerals containing these elements are columbite and tantalite, which are really iron salts of columbic and tantalic acids. Usually a part of the iron is replaced by manganese, and small amounts of titanium, tin and tungsten are almost always present. To lesser extent it occurs with rare earths in samarskite and other minerals.

For the production of metallic tantalum tantalite is the most desirable ore and should contain at least 60 per cent of the oxide and only a few per cent of columbium oxide.

The first step involved in the production of metallic tantalum is the extraction of pure compounds of tanta-

*Paper, slightly abridged, presented at the Richmond meeting of the American Institute of Chemical Engineers, Dec. 6-9, 1922.

lum from the mineral tantalite. This involves the separation of the columbium which may be present.

There are a number of methods available with which to attack this ore. As the most suitable method for the separation of tantalum from columbium is through the difference in solubility of the potassium double fluorides, the method employed should be directed toward the easiest method of production of these compounds. The pulverized ore may be fused with potassium bisulphate. On leaching this fusion, the acids of tantalum and columbium remain insoluble and can be dissolved in hydrofluoric acid and treated with potassium fluoride, or the mineral may be fused with acid ammonium fluoride and the tantalum precipitated from the solution of the melt by means of potassium fluoride.

A method which is more easily carried out on a large scale is the fusion of the finely pulverized ore with potassium hydroxide, which converts the tantalum and columbium into soluble columbates and tantalates. The filtered solution containing these salts may be treated with a mineral acid, preferably nitric or sulphuric acid, which precipitates the insoluble acids of tantalum and columbium. After washing, these are dissolved in hydrofluoric acid and the solution is treated with sufficient potassium fluoride to produce the double fluorides K_2TaF_7 and $K_2CbOF_5H_2O$. These two salts are readily separated by crystallization, inasmuch as the columbium salt is about twelve times as soluble as the tantalum double fluoride.

The oxide of tantalum can be produced from this double fluoride by treating the solution of the salt with ammonia, precipitating the acid, which can be washed and then ignited to oxide.

Production of Metallic Tantalum

It is perfectly evident at the present time that the early attempts to produce metallic tantalum, involving such methods as the reduction of the oxide with carbon in an electric furnace, the reduction of tantalum oxide with aluminum by the Thermit process or the reduction of the oxide by means of misch metal (mixed cerium earth metal), could not have given a product characterized by any degree of purity, and most certainly a metal which could not be subjected to any mechanical working.

Metallic tantalum powder can be produced by the reduction of the double fluoride with metallic sodium or potassium. It is impossible by this process to produce a powder characterized by high purity. For best results by this method the reaction should be carried out in a vacuum, the boats or crucibles containing the mixture of double fluoride and metallic sodium or potassium being placed in a tube or furnace which can be evacuated before the mixture is raised to the reaction temperature.

The product from this reaction can be treated with water and mineral acids in order to free the metal powder as completely as possible from adhering salt and other impurities. This powder is then compressed into bars and subjected to heat-treatment and finally fusion in a vacuum furnace, the high temperature of fusion eliminating the impurities which may be present. If this process has been completely successful, the fused metal will be found to be ductile and susceptible to mechanical working.

The most characteristic chemical property of tantalum is its unusual resistance to chemical corrosion. It is not attacked by hydrochloric or nitric acids or by aqua regia, either hot or cold. It is not attacked by dilute sulphuric acid at ordinary or more elevated temperatures, but appears to be slowly attacked by boiling concentrated sulphuric acid. Solutions of caustic alkalis do not attack the metal. Hydrofluoric acid seems to be the only chemical agent which will will attack it, and in the case of very pure metal and very pure hydrofluoric acid the action is very slow. A mixture of hydrofluoric and nitric acids will attack the metal with avidity, causing it to go into solution as tantalum fluoride.

If tantalum is heated in the air, the surface becomes blue at a temperature of about 400 deg. C. and at a somewhat higher temperature nearly black. Above a dull red heat the white oxide is produced and the metal gradually burns. This metal combines with avidity with hydrogen, oxygen or nitrogen. It will take up seven hundred and forty times its own volume of hydrogen, producing a very coarse-grained brittle product.

Tantalum containing dissolved gases will be harder than the pure metal and if their quantity is appreciable the metal may even be brittle, so that all annealing or heating operations with tantalum must be carried out in a vacuum. Tantalum burns readily when heated in chlorine gas, producing the volatile pentachloride. Solutions of chlorine, however, are without any action on the metal. Tantalum is not affected by any of the chemicals or antiseptics used in dentistry or surgery probably without exception.

Physical Properties of Tantalum

It has been possible to produce metallic tantalum of an exceedingly high degree of purity, and to produce it in commercial quantities, having a purity of at least 99.5. The pure worked material resembles platinum very much in color and appearance. Its melting point may at present be taken as 2,850 deg. C. The specific gravity of the worked metal is 16.6. The pure metal is characterized by toughness and by its great ductility and malleability.

It has been found possible to reduce a bar of tantalum about $\frac{3}{4}$ in. in diameter to wire of only a few mils in diameter without any intermediate heating to the annealing or equiaxing temperature, although the material is subject to strain hardening, resembling the more common metals such as silver or copper in this respect. Tantalum, however, resembles tungsten and molybdenum in that they may all be worked severely at temperatures below their equiaxing temperatures. Copper and silver may be worked at room temperature, but these metals become quite rapidly strain-hardened so that a further reduction makes it necessary to anneal the metal. Tungsten and molybdenum must be worked at elevated temperatures in the early stages and if they are to be worked at room temperature in the finer sizes any operation corresponding to ordinary annealing must be avoided. Tantalum may be worked at room temperature to a remarkable extent without annealing.

The tensile strength of drawn tantalum wire may reach 130,000 lb., which is considerably more than that of hard drawn copper, nickel or platinum, but less than that of molybdenum or tungsten.

The linear coefficient of expansion is more than that of molybdenum or tungsten and only slightly less than platinum. For this reason it is possible to seal tantalum into glass.

The electrical resistance is quite high, about eight times that of copper and about three times that of tungsten. The accompanying table gives the physical prop-

	Tungsten	Tantalum	Molybdenum	Platinum	Copper	Nickel
Density	19.6	16.6	10.2	21.4	8.80	8.84
Atomic value	9.4	10.9	8.8			
Tensile strength, lb. per sq.in.	490,000	130,000	260,000	Hard 54,000 An'l'd 42,000	62,000 35,000	120,000 70,000
Compressibility, kg. per sq.cm	0.28×10^{-6}	$.50\times10^{-6}$	0.47×10^{-6}	.....	0.76×10^{-6}	.....
Young's modulus of elasticity, kg. per sq.mm.	42,000	19,000	.....	.....	.....	22,000
Melting point, deg. C.	3,350	2,770	2,550	1,755	1,083	1,452
Boiling point, deg. C.	.....	.....	3,617	3,907	2,310	.....
Specific heat, cal. per gram per deg.	0.034	0.0365	0.072	0.0323	0.0936	0.1084
Linear co-efficient of expansion per deg. C.	4.3×10^{-6}	7.9×10^{-6}	5.15×10^{-6}	8.84×10^{-6}	.....	13×10^{-6}
Thermal cond. in cal. per cc.	0.35	0.130	0.346	0.1664	0.7198	0.140
Temp. coefficient of expansion	0.0051	0.00335	0.005	0.0039	0.00393	0.0066
Elec. resistance, microhm per cc. at 25 deg., annealed	5.2	14.6	4.8	9.97	1.87	6.4

erties of tantalum as far as they are at present known, and also those of a number of other metals in comparison.

High Chemical Resistivity Gives It Many Uses

In considering the possible uses for this metal we must take into account its high melting point, its resistance to chemical corrosion and its tendency to absorb all of the common gases. We must also remember that we are limited by its relatively low temperature of oxidation. Tantalum seems to be a very desirable metal for the manufacture of certain dental instruments and dental spatulas, and undoubtedly for other dental and surgical tools or instruments. The metal is not attacked by any of the antiseptics or chemicals used and can be readily sterilized by heat. A surface film of hard material about as hard as agate can be produced on the metal by proper heat-treatment. It will probably be found possible to harden the material throughout, thus combining all the advantages of tempered steel with absolute chemical inertness.

It has been suggested for use in the manufacture of pens and analytical weights. Its use in chemical laboratories and in the chemical industries as containers, parts of pumps and other equipment will undoubtedly depend upon the cost at which the metal can ultimately be produced.

Tantalum is suitable for cathodes in electrochemical analysis. In some respects it is more suitable than platinum. For instance, zinc may be plated directly upon the tantalum, as it does not alloy with the metal. Gold or platinum can be deposited upon the metal, as they can be removed by aqua regia without attacking the electrode.

Undoubtedly tantalum in the form of sheet, wire or ribbon will find application in the manufacture of radio sending and receiving tubes. The property of tantalum of absorbing gases would seem to make the metal its own "getter" in vacuum tubes, and would tend to maintain the high vacuum required, particularly in the sending tubes. It would seem that some part of the lamp made of tantalum could be so constructed that at all times a portion of the metal would be at the proper temperature to absorb gas and would, therefore, tend to maintain a vacuum equilibrium within the bulb.

Use of Tantalum as an Electrolytic Valve

Tantalum has interesting possibilities on account of its property of acting as an electrolytic valve.

If two plates of bright tantalum metal are placed in an electrolyte and the two plates connected to an electric battery, there is an instantaneous flow of current similar to that between plates of the better known metals. Within a few seconds the current flow will drop to a very small comparative value, providing the battery voltage is not too high. The order of the current flow will become that of 1 milli-ampere and less with impressed direct current voltage up to 75 volts when sulphuric acid of the strength ordinarily used for storage batteries is the electrolyte. This drop in current flow will be accompanied by the formation of a film on the tantalum anode, presumably of tantalum oxide. This film often shows beautiful iridescent colors.

If a tantalum plate and a lead plate are placed in an electrolyte and a source of alternating current of the usual commercial frequency is connected to the tantalum and lead plates, the current flow in one direction will be almost entirely shut off and a pulsating direct current will be obtained. In such a set-up this flow of current is accompanied by electrolytic action with evolution of hydrogen gas at the tantalum and oxygen at the lead. The action of the tantalum is, therefore, such that electrons are permitted to flow from the tantalum to release hydrogen ions but are prevented from passing from oxygen ions into the tantalum.

The current derived from this apparatus may be utilized for charging storage batteries, for the electrodeposition of metals, and various other electrochemical actions requiring a direct current.

It is possible, by using two tantalum electrodes in a single cell, so to rectify the current that both half waves of alternating current pass in the same direction. This current may be smoothed out by a suitable series of inductances and capacities to give what is practically a constant direct current.

The efficiency of tantalum as a valve with respect to leakage of the current varies with the impressed voltage, with the electrolyte, current density, etc. Due to the fact that tantalum is very inert toward the chemical action of solutions, there is a wide choice of electrolytes and the life of the tantalum appears practically unlimited.

For a charging set-up with a 6- to 8-volt battery the energy efficiency is approximately 33⅓ per cent, which compares favorably with rectifiers of the hot and cold electrode type and the mechanically vibrating rectifiers.

The tantalum battery charging rectifier is noiseless in operation, has no moving parts and requires attention in only one matter, which it has in common with the storage battery itself—that of distilled water being added to replace evaporated and decomposed water of the electrolyte.

In addition to functioning directly as a rectifier for obtaining continuous current, apparatus built along similar principles may be used for electrolytic condensers and electrolytic detectors and possibly lightning arresters.

Among other metals which have this property of valve action more or less in common with tantalum are magnesium and aluminum. However, owing to the ready susceptibility of both these metals to chemical corrosion, they have not proved very suitable as sources of direct current. Condensers and lightning arresters for high potential transmission lines are commercially used with aluminum plates.

Recent Chemical & Metallurgical Patents

Drying Nitrogen and Hydrogen Prior to Synthesizing Ammonia—F. W. de Jahn of Norway has patented the use of alkali amides such as sodamide as a drying agent for nitrogen and hydrogen gases prior to ammonia synthesis. This is a corollary of his general patent (Serial 200,047) on the synthetic production of ammonia under pressure of 1,400 lb. The drying of the gases takes place at this pressure and no temperature control is necessary. (1,436,949. Nov. 28, 1922. Assigned to Atmospheric Nitrogen Corp. of N. Y.)

Elimination of Phosphorus From Refractory Metals—Ira Paul of Brooklyn has assigned to the Metal & Thermit Co. a patent by which, it is claimed, phosphorus can be separated from vanadium, chromium, uranium and molybdenum and other so-called refractory metals. The process consists in bringing the ore into solution by one of the usual methods and acidifying the filtrate with mineral acid. Alkali is then added until siliceous material is precipitated. After filtration more alkali is added until the solution is only very slightly acid. Alum is then added, and an oxidizing agent such as nitrate, chlorate, etc. The desirable metals are precipitated and may be filtered away from the solution, which contains all the phosphorus in combination with aluminum. (1,437,191. Nov. 22, 1922.)

Process for Aging and Disintegrating Superphosphate Masses—G. A. Bruhn has assigned to the Krupp Co., of Germany, a method for disintegrating and aging superphosphate masses. At present, it is customary to age superphosphate in aging chambers, which permits the crude phosphate and sulphuric acid, after mixing in suitable kettles, to stand for some time. The figure given shows the principle upon which the new apparatus works. The trough conveyor receives the charge from the mixing kettle and allows the material to set in relatively small quantities and the aging thus takes place more quickly than under the old system. It will be noted that as the mix comes down from the kettle onto the conveyor it is forced to spread in the direction in which the conveyor moves, due to the elevation of the charging end. When the mass reaches the discharge end of the conveyor, it is cut with knives or wires and is then ready for storage prior to final mixing. (1,430,621. Oct. 3, 1922.)

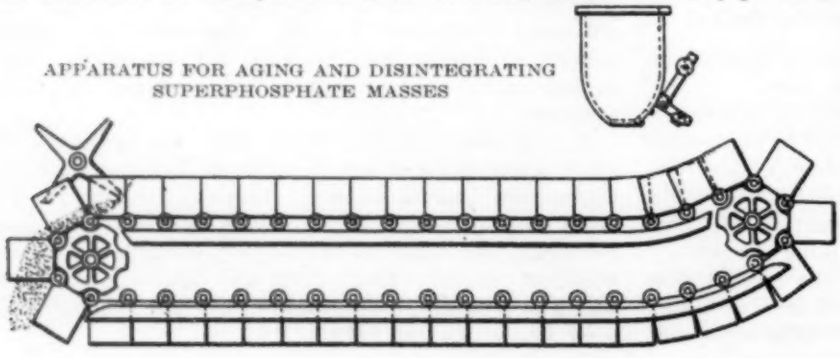
Calcium Arsenate Manufacture—C. B. Dickey, assignor to the Pittsburgh Plate Glass Co., has developed an improvement in the manufacture of calcium arsenate. At present arsenic acid is added to a milk of lime suspension and the calcium arsenate thus produced often contains as high as 2 per cent soluble salts of calcium. These are undesirable, inasmuch as they poison the cotton or other plants on which the substance is used as an insecticide. In order to prevent this formation of soluble salt, ordinary salt from 1 to 5 per cent is added to the milk of lime suspension, which produces a suspension of lime containing a concentration of calcium hydrate in actual solution (solution concentration) higher than normal for that temperature of solution. The soluble arsenate is thus reduced to less than 0.5 per cent and if 0.5 per cent of the soluble salt is permitted to remain in the product, it seems to prevent the formation of soluble calcium salt upon standing. In a subsequent patent, No. 1,428,946, issued Nov. 7, 1922, the process of eliminating soluble calcium salt from calcium arsenate already prepared by the usual method is described and consists essentially in adding to the suspension of the calcium salt some ordinary salt. This, as before, increases the solution concentration of $Ca(OH)_2$ and eliminates soluble arsenates. The basic patent was issued Sept. 12, 1922, No. 1,428,650.

American Patents
Issued Dec. 12, 1922

The following numbers have been selected from the latest available issue of the *Official Gazette* of the United States Patent Office because they appear to have pertinent interest for *Chem. & Met.* readers. They will be studied later by *Chem. & Met.'s* staff, and those which, in our judgment, are most worthy will be published in abstract. It is recognized that we cannot always anticipate our readers' interests, and accordingly this advance list is published for the benefit of those who may not care to await our judgment and synopsis.

1,438,183—Conveying Apparatus.
1,438,190—Grate for Stokers.
1,438,194—Extraction of Grease From Solids.
1,438,221—Manufacture of Linoleum.
1,438,258—Retort Bench and Process of Operating Same.
1,438,342—Reverberatory Furnace.
1,438,357—Extraction of Uranium and Radium.
1,438,421—Oil-Shale Retort.
1,438,471—Wood Impregnation.
1,438,502—Concentrating Liquid Containing Organic Matter.
1,438,537—Separation of Coke From Slag.
1,438,542—Process for Producing Carbon Black.
1,438,558—Recovery of Caffeine.
1,438,565—Recovery of Gaseous Constituents of Oils, etc.
1,438,581—Manufacture of Compressed Hydrogen.
1,438,643—Recovery of Zinc.
1,438,710—Purification of Naphthalene.

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.



APPARATUS FOR AGING AND DISINTEGRATING SUPERPHOSPHATE MASSES

British Patents

For complete specifications of any British patent apply to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Artificial Silk—A spinning bath for use in the manufacture of artificial threads from viscose consists of an aqueous solution of the acids obtained by sulphonating the condensation products prepared by reacting with phenols on aldehydes and ketones, especially ketoses, aldoses, and more especially the various carbohydrates. The bath may also contain mineral acids or the salts of mineral acids and the soluble salts of the sulphonated acids. With these baths, satisfactory results are obtained even with entirely unripened viscose. In an example, a bath for use in making threads of about 2 deniers contains 10 per cent sulphuric acid, 8 per cent Neradol and 10 per cent sodium sulphate; the bath is maintained at 18 deg. C., and a spinning length of 40 cm. with a normal speed of drawing is employed. (Br. Pat. 184,449; not yet accepted. A. Kämpf. Premnitz. Oct. 4, 1922.)

Artificial Silk—Another bath consists of an aqueous solution of the acids obtained by sulphonating the resinous condensation products prepared by reacting with phenols on wood in the presence of acid catalysts. To the bath, mineral acids may also be added, or the acid may be partly neutralized, or to the bath may be added the salts of mineral acids or of the sulphonated acids above referred to; with these baths, satisfactory results are obtained with entirely unripened viscose. In an example, the bath contains 10 to 12 per cent sulphuric acid, 5 per cent sulphonated acid and 15 per cent sodium sulphate; and a spinning speed of 50 meters and a length of bath of 50 cm. are employed. (Br. Pat. 184,450; not yet accepted. A. Kämpf, Premnitz. Oct. 4, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Bureau of Chemistry Emphasizes Achievements

Work of Color Laboratory, Carbohydrate Laboratory and Naval Stores Division of Benefit to Important Industries

IN THE MATTER of appropriations for scientific and technological work, Congress is demonstrating less parsimony than was the case a year ago. Practically all of the technical and scientific bureaus are being allowed small increases.

In justifying the appropriations, representatives of the various bureaus have appeared before the appropriations committee to point out the results of their investigations and to indicate the need for continuing the work. W. G. Campbell, the acting chief of the Bureau of Chemistry, laid emphasis on the importance of the work being done in the Bureau's color laboratory. "One of the greatest difficulties confronting the industry in color manufacture," Mr. Campbell told the committee, "is some means by which there can be a definite and correct identification made of colors. We have been working upon methods of identification by which, upon proper analysis, definite colors can be identified and the extent of the impurities made known." He pointed out that some of the work of the color laboratory "has effected tremendous economy in the manufacture of some of these color products or the basic material from which they are made." He cited the work on phthalic anhydride. He also described in detail the efforts being made to develop a stable biological stain. With regard to the manufacture of synthetic thymol.

"This product has been brought exclusively from abroad, but we have found it possible to manufacture from cymene a synthetic thymol which seems to have every attribute of the product upon which we have depended heretofore. Thymol now sells for $4.50 a pound. We calculate it can be made in this synthetic fashion for $2.50 a pound. When it is considered that two million gallons of cymene are wasted each year in the paper factories of this country and of Canada, the economic significance of that work is apparent."

Research on Sugar

H. S. Paine, in charge of the carbohydrate laboratory, told the committee in detail of the very extensive work which the Bureau has done in the development of more effective methods in the manufacture of sugar and syrups. The Bureau has made possible, he said, the use of invertase in the manufacture of cane syrup by methods devised to prevent fermentation on one hand and crystallization on the other. These methods have been seized upon enthusiastically in the cane syrup-producing sections, it was stated. In addition the Bureau is working on a number of the technological difficulties with which the sugar manufacturing interests are confronted. In co-operation with the producers a uniform grade for cane syrup is being developed. Methods also are being developed whereby more sugar can be obtained from the final beet-sugar molasses. "We have been studying this problem and have been making considerable progress," said Mr. Paine. "We hope before long to develop means of making the process practically 100 per cent efficient."

Naval Stores

Dr S. P. Veitch told the committee of the work being done on naval stores. "Rosin," he declared, "is being substituted more and more largely for fossil resins in the manufacture of varnishes and paints. This is due to the fact that these resins are becoming scarcer and are selling for higher prices. Then too, we are learning to use rosin more successfully, modifying it to take the place of resins."

The work of the Bureau also deals with the question of adulteration and misgrading in both rosin and turpentine. In regard to the turpentine situation, Dr. Veitch said: "Turpentine is selling around $1.50 a gallon in the South. By the time the individual user buys it he pays $2 or more a gallon for it. That induces adulteration with material which costs twenty or thirty cents a gallon. Adulteration is increasing some in the South but most of it is taking place in the paint-using districts. In some states I have found, in asking for turpentine, that I have been delivered mineral oil without a bit of turpentine in it. The high prices have driven turpentine from the market in places."

Sodium Nitrate for Sale

The government has called for bids for 10,017 tons of sodium nitrate held in storage at Nitro, W. Va. The material is offered in lots of 100 tons or more. Bids will be received by the Ordnance Salvage Board, Army Building, 39 Whitehall Street, N. Y., until noon, Jan. 8.

Contemplate New Survey of Chemical Schedule

The Tariff Commission is considering a complete survey of the chemical, agricultural and several other schedules of the new tariff act, affecting which several applications for changes in rates of duty have been filed under the flexible tariff section. Decision as to whether this policy shall be pursued by the Commission will be made after the first of the year.

Several members of the Commission are said to feel that to take up first one application and then another, without regard to the schedule affected, and decide their merits individually without reference to the other paragraphs of the same schedule which might be affected would throw the schedules out of balance.

It has been suggested that the schedules in which the greatest number of applications for changes have been made—chemical and agriculture—be surveyed as a whole, with the applications in mind and also with the purpose of detecting other possible weaknesses which might be disclosed by such a survey and corrected on the initiative of the Commission itself.

The objection to this suggested system of handling the flexible tariff section is that a complete survey of any one schedule would consume months of time and that all relief in specific cases would thereby be held up.

Increase in Helium Appropriation Approved by House Committee

An indication of the value attached to helium for Army and Navy use is had in the approval by the Committee on Appropriations of the House of Representatives of the $6,290,000 appropriation from which the funds are drawn for the operation of the helium plant. This is an increase over the amount allowed in the last Navy appropriation bill and will permit of the continuous operation of the Fort Worth plant during the next fiscal year. The plan includes the production of 12,000,000 cu.ft. of helium. Admiral Moffett, testifying before the committee, declared it is essential to have a larger helium supply as it would not be wise to make any further use of hydrogen in the larger ships at this time, as another accident would deal a heavy blow to the whole lighter-than-air program. At the present time the combined helium stocks of the Army and Navy is 1,822,000 cu.ft.

Annual Meeting of the New Jersey Clay Workers Association

Session Is Signalized by a Symposium on the Casting of Ceramic Bodies and a Discussion on the Oil Firing of Kilns for Textile Porcelain, Tile and Terra Cotta

THE ANNUAL meeting of the New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society was held in the assembly room at the new Ceramics Building, Rutgers College, New Brunswick, Dec. 12. More than 100 members and guests were present from all parts of the state, with visitors from other sections.

The morning session was given over to a symposium on the casting of ceramic bodies, and the afternoon to a similar discussion on the oil firing of kilns, both being particularly pertinent topics at this time with labor troubles and difficulty in obtaining coal.

Following regular routine business, President R. H. Minton, General Ceramics Co., Metuchen, N. J., gave an interesting presidential address in the form of a paper dealing with the ceramic history of New Jersey.

Casting of Ceramic Bodies

The symposium was opened by Andrew Foltz, president of the Lambertville Pottery Co., manufacturer of sanitary ware. He described the installation for handling the slip at this plant, the particular departure being in the use of an air compressor for moving the body from the tank to the shops instead of a pump. There is no agitator in the tank and the natural supposition that the slip would be full of air in its flow through the pipes to the shop apparently does not hold; it has worked with entire success.

The tank is operated by air at about 85 lb. pressure. It is provided with an arrangement for blowing the slip back into the blunger, instead of through the fly pipe to the shop, where such is necessary. The tank, below the floor level, is provided with a float or gage to show the amount of slip it contains. The ceramic body used for the manufacture at this plant runs as high as 18 per cent ball clay.

The next speaker, C. S. Maddock of the Thomas Maddock's Sons Co., likewise a manufacturer of sanitary ware, explained the system used at this plant. It employs the Wainford-Darling equipment, with the addition of a pressure valve and return system, both of which have proved very advantageous.

The pipe runs through the shop and there is a common return to the agitator. The slip is delivered to every man by a hose. An overflow system has been installed and many previous troubles have been eliminated, principally pump action regulated and full supply of slip to the men at all times.

Mr. Maddock spoke of the difficulty in casting wares over 1 in. thick, through balling of the body, which causes cracks, and urged that suitable research be carried out in this direction.

Following this speaker, Eric W. Turner, Trenton Flint & Spar Co., read a brief paper on the casting of grog bodies. He said that a cast sagger will carry the load better than either a hand-made or machine-made sagger. It will probably cost a little more, but is well worth it. In the preparation of the grog slip for this service, sodium silicate and carbonate are used as electrolytes, and the proportions depend upon the physical properties of the clay.

A grog slip, it was pointed out, cannot be handled in pipes on account of the friction, and it must be carried to the molds in a suitable vessel and there poured. The molds are of plaster. With regard to the time element, it was stated that shapes up to 1½ in. in thickness may be cast in the same mold every 6 hours, while those from 4 to 6 in. thick require from 16 to 24 hours.

T. A. Klinefelter, Trenton Fire Clay & Porcelain Co., outlined briefly his experience in casting electrical porcelain. He said that it had been found very quickly that the ordinary high-tension body for jiggering was not a good body for casting; on the contrary, it was a very poor one. Pieces to be cast, as a rule, were of very difficult design, such as bushings with heavy corrugations and the like—material that would hang in the mold. Sanitary bodies were tried, but of course these were too porous to stand up under the necessary electrical test. The balling effect in pieces over 1 in. thick, referred to by Mr. Maddock, was another trouble encountered. With such unsatisfactory results, the casting method, he said, was discontinued.

Calcining Solves Difficulties

In commenting upon the last speaker's difficulties, T. A. McDougal, Champion Spark Plug Co., said that a solution to the problem was the calcining of the porcelain body; it is then ground and introduced into the slip to be used for casting. The matter of calcining, he set forth, was being carried out successfully in the spark plug industry, 45 to 50 per cent of the body being so treated and reduced to pass through a 120-mesh.

Frank Dinsmore, Imperial Porcelain Works, Inc., manufacturer of electrical porcelain, said that this plant was casting wares with complete success, the pieces being 2 to 2½ in. thick, and with practically no loss through cracking. An open mold is used for this work. Additionally, pieces 7½ to 8 in. in diameter and 25 to 26 in. long are also being cast, some of these being quite intricate, with corrugations the entire length. In concluding his remarks, Mr. Dinsmore said that the open mold casting method is the only one which will handle the variations in thickness satisfactorily and bring the desired results.

Presentation of Picture for Ceramics Building

Prior to the adjournment for luncheon, Ross C. Purdy, general secretary, American Ceramic Society, presented a large picture of Edward Orton, Jr., the dean of the ceramic industry, to the Rutgers ceramic department. This picture, mounted in an attractive gold frame, was obtained through subscriptions from the former pupils of Dr. Orton, and will hang in the assembly room.

Election of Officers

Officers were elected for the coming year as follows: Andrew Foltz, Lambertville Pottery Co., president; Charles W. Crane, the Crossman Co., vice-president; Prof. George H. Brown, director of the department of ceramics at Rutgers College, secretary and treasurer; the latter has held this office for a number of years.

Kiln Firing and Relative Fuel Values

Following a luncheon, served in the basement of the Ceramics Building, the afternoon session was opened with President-elect Foltz in the chair, the first address being on the subject of "Kiln Firing and Relative Fuel Values," by Francis W. Walker, Jr., Beaver Falls Art Tile Co.

Mr. Walker explained that owing to the disturbed fuel markets, his company had experimented with coal, gas and oil, and had made careful tabulations of the results obtained from each fuel and its relative value in actual operating service. The success with any fuel, he pointed out, depends largely upon the character of furnace and its design, as well as upon the equipment used. For instance, in the case of gas, the consumption is proportionally greater in the up-draft kiln than in those of the down-draft type. The average coal consumption for seventy-three 16-ft. down-draft kilns was 12.8 tons, whereas the gas consumption for these same kilns averaged 360,000 cu.ft., which if expressed in B.t.u., figuring coal at 14,000 B.t.u. per lb. and gas at 1,000 B.t.u. per cu.ft., shows a thermal variation of less than one-half of one per cent.

Taking typical figures for a month, this being September, 1922, it was shown that the total cost of coal firing was $13.14 per ton, including the price per ton, labor cost, maintenance and sagger breakage; in the same month the cost of gas firing, using 28,000 ft. of gas at 45 cents per thousand, was $15.10; and the cost of oil firing, using 197 gal. of oil at 6¼ cents, was $15.69. These results, expressed in terms of percentage, were as follows:

	Coal	Gas	Oil
Fuel	46.2	83.5	78.2
Labor	20.4	6.9	6.6
Maintenance	10.8	1.6	5.5
Sagger breakage	22.6	8.0	9.7
	100.0	100.0	100.0

NEW JERSEY CLAY WORKERS ASSOCIATION AT NEW BRUNSWICK

The average cost of firing with the respective fuels are as follows, showing oil to be the most expensive: Coal, $12.84; gas, $15.25; and oil, $16.59. The problem in the case of gas and oil is one of purchasing economically, while in the matter of coal, all items must be considered, especially that of labor, on account of the disagreeable nature of the work and the overlapping of responsibilities caused in the different working shifts of 8 to 12 hours each, as the case may be.

The application of pyrometric equipment becomes of utmost necessity, particularly when firing with coal. If but a single record is taken, only limited control is possible, and it becomes necessary for the fireman to judge his work in the other parts of the kiln by comparison. Where possible, this should be overcome with the use of either the optical pyrometer or a four-point recorder, a couple in each quarter of the kiln, or both. With regard to the effect of the fuels upon the quality of the ware, Mr. Walker said that he was firmly of the opinion that with very few exceptions equal results can be secured with each character of fuel.

Oil Firing for Textile Porcelain

John A. Williams, Mitchell-Bissell Co., the next speaker, set forth that the use of oil fuel had proved highly successful at his company's plant, which has been operating by this method since early in 1920. The company specializes in the production of porcelain guides for textile mill service.

He said that all equipment had been purchased in duplicate to avoid any possibility of shut-down through failure of apparatus. This includes two oil pumps, two air blowers, two strainers, and so on. Each kiln at the plant is provided with six burners, with air piping, air gage, valves, etc., costing about $300.

The product is a highly vitrified one; it is fired to cone 12 in one burn—that is, the body and glaze are handled all at one time—and results are being obtained with oil fuel that could not, in Mr. Williams' opinion, be duplicated with coal. One man is handling three kilns at this pottery. Two different size tips are used on the oil burners, the smaller one being employed at the beginning of the burn and until its near-maximum is reached, at which time the change to the larger one is made.

On a 13-ft. kiln, using six burners, with an average burning of 44 hours, about 1,760 gal. of oil was consumed for each burn over a period of a year; on a 14-ft. kiln, with eight burners, the average is from 2,300 to 2,400 gal. of oil per burn of 42 or 44 hours. At the present time a price of 7 cents a gallon is paid for the highest grade fuel oil, 36 to 40 deg. Baumé, delivered at the plant. Four pyrometer tubes are installed in each kiln, one in each quarter; also, an indicating instrument is placed in the kiln shed for the guidance of the fireman at all times.

Oil Firing for Tile

Donald Hagar, Mosaic Tile Co., gave a comprehensive outline of the installation for oil burning at this plant, utilizing a low-pressure system, or with air pressure never exceeding 2½ oz., volume, rather than pressure, being relied upon to supply the necessary air for combustion. The pressure on the oil varies from 30 to 45 lb., as the conditions warrant.

All the burners are fitted with mixers for admitting auxiliary air, providing a further regulation for lengthening or shortening the flame. A rotary pump delivers the oil from the storage tank through a heater and thence to a 1-in. circular pipe which surrounds each kiln, and then to the burners through ⅜-in. outlets in each pipe.

Two important factors to be considered were mentioned, these being the atomization of the oil and the amount of air admitted to the burners. The effect of poor atomizing is to facilitate the formation of carbon in the fireboxes and to produce incomplete combustion. This condition can be prevented by controlling properly the temperature and the pressure. With respect to air supply, it was pointed out that the amount of air supplied to the burners bears a distinct relation to the amount of oil consumed. A deficiency in air produces incomplete combustion, while an excess will shorten and intensify the flame, thus using more oil than necessary.

In speaking of the advantages of using fuel oil, Mr. Hagar listed these as a comparison with coal, enumerating as follows: (1) Produces a more intense heat, thus cutting down the burning time; (2) the kiln is regulated more easily, affording a more uniform burn; (3) less labor is required; (4) less space required around the kilns; (5) makes for a cleaner kiln shed; (6) smaller storage space required; and (7) no strikes to interfere with the supply.

With regard to cost, he stated that a rough estimate would show that it cost about $10 more to burn the bisque kilns at the plant with oil than with coal. On the other hand, the cost is reversed in favor of the oil in the same ratio in the glaze kilns.

Oil Firing for Terra Cotta

G. M. Tucker, New York Architectural Terra Cotta Co., gave a brief résumé of the installation at the plant of his company and the results being secured through the use of oil fuel. One of the greatest advantages, he said, was the ease of control of the fires at any stage of the burn, giving a pyrometric curve that is very regular, without the peaks and depressions as found in the case of coal.

The equipment at his plant consists of five depressed oil reservoirs, varying from 10,000 to 25,000 gal. capacity, small duplex pump, and auxiliary piping and apparatus. The oil burner used is of the internal mixer type, in which the oil and air or steam mix before leaving the nozzle. Compressed air is used as the atomizing agent, and the oil employed varies from 18 to 20 deg. Baumé. Mention was made of the advisability of installing equipment in duplicate for emergency service.

The last speaker in the symposium was C. F. Geiger, of the Carborundum Co., who gave a digest of the use of the refractories manufactured by this company for various character of oil-burning service.

Among the speakers of the afternoon session, Ross C. Purdy, general secretary of the American Ceramic Society, tendered an interesting address on the value of technical research, saying that for every dollar so expended many fold return came to manufacturers of ceramic products and the industry as a whole. Mr. Purdy also spoke briefly on the work and aims of the American Ceramic Society.

Denaturing Provisions Make Prohibition Enforcement Easier

Specifications of Benzol Required for Denaturing Alcohol for Rubbing Purposes

With the new regulations affecting changes in formulas for denaturing alcohols for rubbing purposes in operation, the prohibition unit of the Treasury Department believes that practically all has been done that can be safely done to relieve the industrial alcohol business from any possibility of connection with the illicit liquor traffic.

The new regulations, prepared by Dr. Doran of the industrial alcohol division of the prohibition unit, provide that three-eighths of one per cent of benzol shall be mixed with alcohol intended for rubbing purposes. The benzol is difficult to remove and it is easily detected by taste, yet does not injure the alcohol for rubbing purposes.

"Benzol sends its own warning through the sense of taste," said Dr. Doran. "Of course the easiest way to denature alcohol is by use of wood alcohol, but this is both odorless and tasteless and it is this fact which leads to death and injury when chances are taken. The object of denaturization, as we conceive it, is not to murder but to warn."

The specifications for benzol which hereafter must be used in the three formulas of odorless alcohol affected by the order are:

SOLUBILITY

When 10 c.c. of benzol are shaken with an equal volume of water in a glass-stoppered cylinder, divided into tenths of a cubic centimeter, and allowed to stand five minutes to separate, the upper layer of liquid must measure not less than 9.5 c.c.

BOILING POINT

When 100 c.c. of benzol are subjected to distillation in the same manner as described for the boiling point of wood alcohol, not more than 1 c.c. should go over at 77 deg. C., and not less than 95 c.c. at 85 deg. C.

This order, which went into effect December 6, removes the last of the major causes of complaint that industrial alcohol was being denatured and used for purposes violative of the prohibition amendment, according to Dr. Doran.

RECOGNIZE EFFORTS OF INDUSTRY TO CONFORM WITH LAW

The industrial alcohol interests have been striving earnestly to remove their business from any connection with the illicit liquor traffic. Of the approximately 70,000,000 proof gallons of industrial alcohol produced in the United States last year, something more than 50,000,000 proof gallons were completely or partially denatured by the more than 70 formulas, and there were withdrawals of only approximately 3,000,000 proof gallons of the class which caused the trouble to the prohibition unit, and only a small fraction of this was used fraudulently.

ENFORCEMENT BECOMING EASIER

Wholesale and retail druggists are co-operating with the prohibition unit, through their associations, to help drive out the undesirables, the officials report. It is being made more difficult for so-called wholesale druggists to start business in order to become wholesale whiskey dispensers. When the prohibition amendment first became operative, there was considerable trouble with such camouflaged concerns, which started up business in all sections of the country. For the first time, the drug stock jobber made his appearance in the United States. Also, some of the new firms sold drugs at cost, or less, to encourage their liquor business.

These things are being overcome, the prohibition unit reports, and legitimate druggists are assuming command of the situation and following the law closely.

This, with the general improvement in the industrial alcohol situation, is making administration of the prohibition laws much easier and at the same time placing legitimate business on a plane safe from the business pirates who threatened it.

Bureau of Standards Bids Stratton Farewell

A farewell reception in honor of Dr. Samuel W. Stratton, director of the Bureau of Standards and president-elect of Massachusetts Institute of Technology, was held at the Bureau on Dec. 14.

The formal reception, in the industrial building, was followed by a trip through the various laboratories. A collection of exhibits from other buildings had been assembled on the third floor and attracted many of the visitors from the floor below where the U. S. Marine Band was furnishing splendid dance music.

Dr. Stratton has been Director of the Bureau since its establishment in 1901. The sentiment of his staff is well expressed by the following words of appreciation.

> The Bureau is an enduring monument to Dr. Stratton and those who through the early years of development stood for high standards of effort and attainment. Nations and industries, inspired by the Bureau, are founding similar institutions. Endowed research and industrial standardization have grown apace with the Bureau. Within its walls hundreds have been trained. From its staff industry recruits experts, and they carry the spirit of creative research which it is our privilege to cherish. In leaving us, our chief will prize most our assurance that we shall keep burning steadily and pass on undimmed the torch of inspired effort. That torch gives energy and enlightenment—two essentials of life and industry.

E. C. Franklin Elected President of A.C.S.

Bancroft and Hoskins Chosen as Directors—Four Councilors-at-Large Also Elected

Edward C. Franklin, professor of organic chemistry of Leland Stanford Junior University, has been elected president of the American Chemical Society, succeeding Edgar F. Smith of the University of Pennsylvania.

Wilder D. Bancroft of Cornell University was reelected a director of the society and William Hoskins, consulting chemist of Chicago, was made a new director of the society. The following councilors-at-large for the period from 1923 to 1925 also were elected: Roger Adams, University of Illinois; G. N. Lewis, University of California; Ralph H. McKee, Columbia University, and Dr. William McPherson, Ohio State University.

Dr. Franklin, the new president, was born at Geary City, Kansas, in 1862. He was graduated from the University of Kansas in 1888 and received his master's degree in 1890. He was a student at the University of Berlin in 1890 to '91 and received his Ph. D. at Johns Hopkins University in 1894.

He was a member of the advisory board of the Bureau of Mines in 1917 to '18; physical chemist of the Bureau of Standards and consulting chemist of the ordnance bureau of the Army during the war. Dr. Franklin's work on liquid ammonia as an electrolytic solvent is familiar to all chemists. In addition to his university work, hé was in industrial work for a number of years, having had experience in the sugar industry and also in the gold mining industry. In the latter work he was stationed at Miramar, Costa Rica, in 1897.

Dr. Franklin was chosen from the four nominees for president of the Society who received the largest number of votes. The choice among these four was determined by a vote of the councilors of the society. The three other leading candidates were James F. Norris of Massachusetts Institute of Technology, Samuel S. Parr of the University of Illinois, and Charles L. Reece of E. I. du Pont de Nemours & Co.

Canadian Atmospheric Nitrogen Plant Will Resume Operation

Plans are being formulated for the further development of an atmospheric nitrogen products industry in British Columbia. A plant was established four years ago on the site of the British Columbia Electric Railway Company's plant at Lake Buntzen by an American company which operated throughout 1920 and a part of 1921, using the surplus energy generated by the electric company. Operations are about to be resumed with a daily output of about five tons of sodium nitrate and nitric acid. The plant will operate twenty-four hours a day and employ thirty-five men for the present, but should plans materialize the industry will be developed on a large scale.

American Metric Association Plans Meeting in Cambridge

The annual meeting of the American Metric Association is to be held on Dec. 30, at Massachusetts Institute of Technology, Cambridge. United States and Canadian Government departments, industrial and commercial organizations and corporations interested in metrology are especially invited to have representatives present.

The addresses and discussions at all sessions will be confined chiefly to those actually engaged in commerce or industry. Those primarily interested in education, public welfare, and co-operation between nations, are regarded as natural allies in the metric movement.

The Decimal Association of London, working in England for decimal currency and metric weights and measures, has requested the co-operation of the American Metric Society in urging the abandonment of the British and American gallons and the adoption in their place of the international liter as their common unit of capacity.

The liter is less than the Imperial quart and greater than the American quart, and its adoption would thus—in effect—strike an average between the existing British and American practices.

Ask Fertilizer Man's Aid to Relieve Car Shortage

Efforts by Shippers to Sell Carload Lots and Deliver in Off Seasons Would Improve Conditions

A plea for the use of cars during other months than those of the late summer and fall has been made to the National Fertilizer Association by M. J. Gormley, the chairman of the car service division of the American Railway Association. It is a reply to the various complaints which have been lodged with his organization by numerous fertilizer manufacturers who have suffered from their inability to obtain enough cars. While the association is willing to admit that shippers have an important responsibility in obtaining the prompt release of cars, there is a feeling that the great losses entailed by the annual car shortage is so much greater than the relatively small loss resulting from cars being unemployed during certain months that some steps must be taken to increase the amount of equipment available when the freight movement is heaviest.

Mr. Gormley pointed out that from January, 1912, to November, 1922, the country has passed through 87 months of car surplus and 43 months of car shortage. Surplus cars ranged as high as 486,000 averaged monthly, with shortages of about 166,000 cars. During these periods only 64 per cent of the capacity of freight cars was utilized. Car loading reached its peak during the fall of 1920 and figures indicate that approximately 2,250,000 fewer cars would have been used during the year 1921 to handle the same amount of tonnage provided the cars had been as heavily loaded during the entire year of 1921 as they were during the last quarter of 1920. The loading per car of many commodities for the first 6 months of 1922 had declined under the 1921 basis, hence it is timely from both the standpoint of the carrier and the shipper to stress the necessity for greater effort in this regard.

Relief Measures

Directly related to the more efficient use of equipment and the spreading out of the distribution of the seasonal movement of commodities is the willingness and ability of the purchaser to place his orders for full carloads, not in fixed quantities as may be governed by set tariff minimums or trade units. Furthermore, the purchaser should be induced to place his orders in advance of his immediate necessities and wherever possible to carry a stock of the products which will allow the producer to make shipments during periods of the year when transportation facilities are least congested and when thousands of cars or locomotives are normally available to effect quicker dispatch.

New Italian Ambassador to Be Welcomed by Fellow Engineers

American engineers are planning a big reception to Prince Gelasio Caetani, Italian Ambassador to Washington, now on his way to this country. A dinner, at which engineers from all parts of the country will be present, will be given in honor of the new diplomat, himself an engineer, by the American Engineering Council of the Federated American Engineering Societies in Washington on the evening of Jan. 12.

"Joyfully returning to states which have been my second home," said a cable message from Prince Caetani to Colonel Arthur S. Dwight, member of the executive board of the American Engineering Council and president of the American Institute of Mining and Metallurgical Engineers. "Ready to devote myself to the good of both countries. I am looking forward with intense pleasure to meeting old friends at dinner kindly offered. Expect to arrive Dec. 20."

Personal

Ernest G. Jarvis, superintendent of foundries and rolling mills for the McNab & Harlin Mfg. Co., Paterson, N. J., has resigned, effective Jan. 1, 1923. Mr. Jarvis expects to take a much needed rest for a few months and about Jan. 15 will sail for a cruise of South and Central America. After his return he will resume his metallurgical activities in a consulting way.

Dr. Charles F. Kettering, president of the General Motors Research Corporation, addressed the Harvard Medical Society at the Harvard Club, New York, on Dec. 15, on the subject "An Engineer's Perspective of Modern Science."

Dr. Irving Langmuir gave a series of three lectures at the Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 27, 28 and 29, on recent discoveries in electron emission and current control.

A. E. Marshall has resigned as president of Marshall Rieha, Inc., and will in future devote his attention solely to plant design, consultation and report work for the chemical industry. His office is at 3034 St. Paul St., Baltimore, Md.

David J. Price, engineer in charge of development work of the Bureau of Chemistry of the U. S. Department of Agriculture, recently in addressing the Safety Bureau of the Chamber of Commerce, Buffalo, N. Y., declared there is no such thing as a spontaneous explosion and called attention to the danger of dust explosions in various kinds of industrial plants and discussed the methods of prevention that have proved effective.

Dr. J. W. Reedy was recently elected chairman of the University of Illinois section of the American Chemical Society. Prof. A. M. Buswell was chosen vice-chairman, Dr. D. M. Engles secretary and Edith H. Nason treasurer.

Franklin H. Smith, former assistant secretary of the National Lumber Manufacturers' Association, has become associated with the U. S. Tariff Commission as chief of its Forest Products Division. Mr. Smith was for many years connected with the U. S. Forest Service.

Dr. Samuel Wesley Stratton was the guest of honor at a farewell reception at the Bureau of Standards on Thursday, Dec. 14. The program included a most elaborate display of interesting work of the bureau and a visit to a number of the industrial laboratories. Dr. Stratton was presented with a fine silver service from the members of the staff of the bureau.

Hugh S. Taylor has been promoted by the trustees of Princeton University to a full professorship in the department of chemistry, with the title of professor of physical chemistry.

Dr. John E. Teeple expects to sail for London on Jan. 2.

Stanley Woodward, formerly director of purchases for The Barrett Co. and W. B. Harris, formerly general sales manager of the same organization and later assistant to the president, have resigned. Together with T. M. Rianhard, formerly president of The Barrett Co., they expect to engage in the roofing business in Baltimore.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Guessing About Credits

Most Business Failures Are Caused by Lack of Discretion on the Part of Selling Houses

It must be admitted that there is no substitute for good judgment in business, but the average business man can profitably spend a considerably larger share of his time in analyzing the problems of production and distribution. A phase of the latter subject which, according to a recent statement of the National Association of Credit Men, has not received the attention it deserves, has to do with credit matters. The association declares that in the field of credits there is too much guessing and too little critical investigation. In part, the statement is as follows:

"When conceding that a large proportion of commercial failures are accounted for by the indiscretions of the selling houses, then surely the thesis cannot be successfully contested that in credits too much is taken for granted and the surface is too frequently regarded as indicative of the entire situation.

"When serious wastes may happen—and they have happened with us frequently because of these defects—then it is high time for us to become economic observers, closer students of markets, with more individual ability to forecast the future and to appraise the real qualities of a credit risk.

"We cannot regard excessive bad debt losses without conceding that critical investigation was lacking.

"Waste is deplorable, especially when it need not happen, and we appeal to the commercial and credit workers of the nation to increase their powers of economic observation; to develop a critical ability that will insure a proper flow of commodities and a volume of credits that will liquidate with a small amount of loss."

Chemical Exports Holding Their Own

Total Shipments for 10 Months Valued at $87,901,236, Only One-Half Per Cent Less Than in 1921

Exports of chemicals and allied products for the 10-month period, January-October, 1922, compared with the corresponding period in 1921, indicate that chemicals are holding their own, according to C. Concannon, acting chief of the Chemical Division of the Department of Commerce. Total exports for the period were $87,901,236 in 1922, which is not quite one-half of one per cent less than in the corresponding 10 months of 1921.

While the percentage of increases in certain classes in 1922 over 1921 are not as high as during the previous period, January-September, the percentage of decreases in others are lower. Of the sodium compounds exported, caustic soda showed a gain of 244 per cent; borax, 190 per cent; sodium silicate, 21 per cent; and soda bicarbonate, 11 per cent; while soda ash recorded a loss of 24 per cent. Sal soda decreased 15 per cent in value, but gained 3 per cent in quantity.

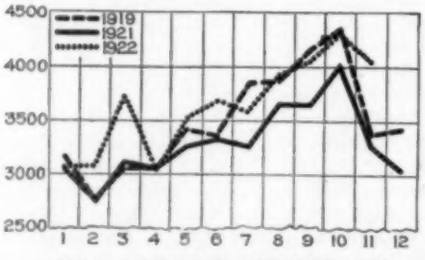
Of the other chemicals recording marked improvement, nitric acid was the most important, advancing over 120 per cent in value, from $18,906 (122,794 lb.) in 1921 to $41,863 (630,646 lb.) in 1922. Shipments of wood and denatured alcohol increased from 344,853 gal., valued at $400,056, to 1,028,181 gal., valued at $735,473; glycerine from 1,411,223 lb., valued at $231,698, to 2,594,808 lb., valued at $381,543; acetate of lime from 15,139,051 lb., valued at $331,960, to 24,653,025 lb., valued at $501,325; bleaching powder from 12,815,794 lb., valued at $363,589, to 33,188,418 lb., valued at $545,483, and copper sulphate from 3,132,306 lb., valued at $196,382, to 4,675,115 lb., valued at $224,647. Benzol, carbolic acid and sulphuric acid all showed decreases in 1922.

A Year of Business Expansion

Freight Car Loadings During 1922 Clearly Indicate the Improvement Over 1920 and 1921

Freight car loadings represent distribution of commodities and therefore constitute an accurate index of the movement of general business. If the total monthly loadings of revenue freight are compared for the years 1919, 1921 and 1922, some interesting information is disclosed. In the first place, it is scarcely necessary to show that 1921 was a year of depression. But it is interesting to note that except for the one month of April (the first of the coal strike) loadings during the current year have exceeded those of 1921 and have very closely approximated the records of 1919. The peak in both cases was reached about the middle of October, but the seasonal drop during November has been less abrupt during 1922 than in 1919.

This indisputable evidence of business expansion is shown graphically in the accompanying chart, which has been copyrighted by the Harvard University Committee on Economic Research.



TOTAL LOADINGS OF REVENUE FREIGHT BY MONTHS, 1919, 1921, AND 1922
(*Unit*: 1,000 *cars*)

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	168.35
Last week	168.73
December, 1921	145
December, 1920	245
April, 1918 (high)	286
April, 1921 (low)	140

The principal changes reported among the index commodities were for cottonseed and linseed oils. The former was ¼c. per lb. lower than last week, while linseed oil showed a gain of 3c. per gal. Ammonium sulphate showed a net gain of 5c. on the 100 lb.

Alcohol Statistics for 1922

Annual Report of Internal Revenue Commissioner Reviews Production and Distribution of Alcohol

The industrial alcohol and chemical division of the Bureau of Internal Revenue has recently prepared an interesting summary of its operations during the year ended June 30, 1922. At the close of the last fiscal year, it reports, there were seventy-three industrial alcohol plants, seventy-eight bonded warehouses and seventy-four denaturing plants qualified to operate for the production, storage and denaturation of alcohol, respectively, under Title III of the national prohibition act. During the year nine industrial alcohol plants, ten bonded warehouses and twelve denaturing plants were established, while six industrial alcohol plants, eight bonded warehouses and three denaturing plants were discontinued, resulting in a comparatively small net increase over the number qualified on June 30, 1921. For the production of distilled spirits for nonbeverage purposes, other than alcohol, there were operated during the year

two grain distilleries, two rum distilleries and thirty-three fruit distilleries.

Distilled Spirits — During the fiscal year ended June 30, 1922, there was produced 79,906,101.51 proof gallons of alcohol, a decrease of 5,162,674.82 proof gallons compared with the quantity produced during the preceding fiscal year.

There was withdrawn from warehouse on payment of tax 16,363,301.85 proof gallons of alcohol, and there was withdrawn for tax-free purposes, including withdrawals for denaturation, for export and for use of the United States hospitals, laboratories, colleges and other educational institutions, a total of 63,147,767.22 proof gallons of alcohol.

There was withdrawn, tax paid, from distillery, general and special bonded warehouses 2,724,363.4 taxable gallons of distilled spirits (including brandy) other than alcohol, a decrease of 6,352,782.1 gal. compared with the quantity withdrawn tax paid during the preceding year.

Denatured Alcohol — The number of bonded manufacturers using specially denatured alcohol at the end of the fiscal year 1922 was 3,287, compared with 1,761 such manufacturers at the end of the fiscal year 1921. The increase of 1,526 was due to the qualification of many permittees heretofore using pure alcohol. During the same period of time sixty-seven permits to use specially denatured alcohol were revoked by the department.

During the fiscal year 1922 there was withdrawn from bond, free of tax, for denaturation 59,549,919.6 proof gallons of alcohol and rum, against 38,812,138.7 proof gallons withdrawn for this purpose during the previous year.

There was 33,345,747.91 wine gallons of denatured alcohol produced during the past fiscal year, of which 16,193,523.60 wine gallons was completely denatured and 17,152,224.31 wine gallons was specially denatured, compared with 22,388,824.92 wine gallons of denatured alcohol produced during the previous fiscal year, of which 12,293,595.02 wine gallons was completely denatured and 9,996,229.90 wine gallons was specially denatured.

Less Oleomargarine in 1922

In order to exact the internal revenue tax on oleomargarine it is necessary for the government to keep an accurate record of production and consumption of this commodity. The Commissioner of Internal Revenue in his annual report for the fiscal year 1922 has presented some interesting statistics on this industry.

During the year ended June 30, 1922, there were seventy-two oleomargarine factories in operation. Nine factories closed during the year, leaving sixty-three in business on June 30, 1922. The seventy-two factories produced 6,603,981 lb. of colored and 184,346,392 lb. of uncolored oleomargarine, compared with 11,600,319 lb. of colored and 269,481,195 lb. of uncolored oleomargarine in the fiscal year 1921, a decrease of 43.1 and 31.6 per cent, respectively.

Babson's Views on Linseed Oil

The Babson statistical organization has recently been advising its clients against laying in heavy stocks of linseed oil. Apparently precautions should be taken to insure adequate supplies for the next few months, but it is not considered advisable to build up any considerable inventories. The *Buyer's Bulletin* for Dec. 12 contains the following statement: "We do not advocate heavy inventories of linseed oil, because supplies of this commodity are undoubtedly adequate to meet the prospective demand. The domestic flaxseed crop is the largest since 1918, estimated at 12,101,000 bushels—a marked increase over the 1921 crop of only 8,112,000 bushels. Then again Argentina is growing a tremendous amount of this commodity. Recent estimates place this season's crop at 60,000,000 bushels, as against only 30,000 000 last year. It is true that there is a tariff on the seed, but it is not sufficiently high to keep foreign seed out of the country. Imports of linseed oil prior to the tariff were extremely heavy, being six times as large as those of last year. The probable demand is fairly good, but we feel that it is discounted by current prices, which are 50 per cent above pre-war levels."

Cost Studies a Legitimate Activity of Trade Associations

Trade associations or groups interested in cost accounting may meet solely for the purpose of the study of costs, the detection of errors and the improvements of their methods without contravention of law, in the opinion of Commissioner Nelson B. Gaskill, of the Federal Trade Commission.

"I have previously expressed my firm belief," said Commissioner Gaskill, "that cost accounting is a legitimate trade association activity, and subsequent consideration has merely strengthened this conviction. Collective analytical study of the results of cost accounting furnishes an invaluable supplement to the individual cost accounting work. Comparison of results, analysis of results and the study and discussion of these results lead to the improvement of methods and the increase of efficiency. To prohibit collective study of costs for the purpose of their analysis, the detection of errors, and the improvement of methods, is to shackle educative progress.

"Of course the legal situation is confused by reason of the decisions in the hardwood lumber case and the linseed oil case, and it will be some time before this confusion will be cleared by any additional authoritative decisions. Trade associations must therefore determine as accurately as they can the legitimate field of proper endeavor and having so taken counsel, should, without hesitation, resting upon their legal advice and the clear consciousness of the propriety of their efforts, proceed without fear, willingly inviting the test of the courts' consideration of their conduct."

Solvents at Higher Levels in New York Market

Formaldehyde, Arsenic and Methanol Are Also Firmly Maintaining Recent Advances

Manufacturers of fusel oil, ethyl acetate and amyl acetate have announced a new advance in prices. The demand has become more pronounced of late and sellers have not been eager to book round lot business. The new price of fusel oil represents the high mark for 1922 and shows a net advance of $1 per gal. since January. Although producers of acetic acid, acetone and calcium acetate have not yet raised their prices, it is generally agreed in the trade that some revisions will be announced before the turn of the new year. Resale lots of formaldehyde are being quickly disposed of and the market is rapidly coming into the hands of the producer. Arsenic still continues along very steady lines, with demand very strong from the insecticide and calcium arsenate manufacturers. Manufacturers report a completely sold up condition at the works. Methanol retained its recent advance.

The approaching holidays seemed to have a quieting effect on the general list and aside from the rise in solvents the market showed no special features. Carbonate of potash was somewhat weaker and prices were fractionally lower. Lead arsenate, on the other hand, showed a very strong tendency and prices recorded an advance of 6c. per lb. during the interval. The alkali market continued along moderately active lines, with domestic consumers showing considerable interest in future developments. Contracts over 1923 have gone through in far better volume than a year ago and producers are quite satisfied with the general trend.

High Spots in the Market

Arsenic—Producers are not quoting and second hands report a very light supply on the spot market. Small quantities were recorded around 15c. per lb. Future shipments are held at 14½@14¾c. per lb., N. Y.

Bleaching Powder — Manufacturers reported a strong demand from consumers for contracts over 1923. Carload lots were quoted at $1.90 per 100 lb., f.o.b. works. Spot goods were held around $2.25 per 100 lb. in large drums.

Barium Chloride—Imported material was somewhat lower, due to the lack of consuming interest and prices were quoted down to $90@$95 per ton. Domestic factors quoted goods at the works at $95 per ton.

Ethyl Acetate—Leading producers announced a new price advance due to increased production costs. New prices range from 80@85c. per gallon.

Formaldehyde—Second hands were not eager to quote at lower than producers' prices and the market is very strong. January shipments were quoted for carloads at 16c. per lb., and less than carloads at 16½c. per lb. Spot goods were quoted around 15¾@16c. per pound.

Fusel Oil—Producers reported another increase in prices. Spot material is being held around $3.55 per gal. This represents the highest level of the year and shows a gain of $1.05 per gal. since January, 1922.

Lead Arsenate—Manufacturers announced a sharp advance due to the increased production costs and heavy demand from consuming quarters. Late figures ranged around 20c. per lb., showing an advance of 6c. per lb. within an interval of one week.

Prussiate of Potash—Yellow material showed some signs of weakness and prices were fractionally lower on spot. The general range was 38½@39c. per lb. Red prussiate showed no new features of interest and prices remained around 92@95c. per lb.

Soda Ash—Export business was quiet during the past week, but domestic consumers were buying for contract requirements. Spot material in bags, carload lots, held around $1.75 per 100 lb. Contracts for over 1923 were being made at $1.20 per 100 lb., basis 48 per cent, f.o.b. works, carload lots.

Good Prospects for 1923 in Chicago Market

Current Business, However, Slackens Off for Holidays

CHICAGO, Ill., Dec. 22, 1922.

The outlook for next year's business in the Chicago market was reported as exceptionally good and a general feeling of optimism prevailed throughout the trade. Due to the approaching holiday season and the inventory period, however, the chemical market has been very quiet. No business of any consequence was reported from most quarters, but the condition was thought to be only temporary. Prices held firm, as it was quite evident that lower prices would not stimulate the market.

CAUSTIC SODA FIRMER

Firm prices were the feature of the *caustic soda* market during the past 2 weeks and a fair amount of spot business was reported. The solid 76 per cent material was quoted in ton lots at $3.50 per 100 lb. and the ground in like lots of a similar quality at $4.25. *Caustic potash* was in rather poor demand, with only supplies of the foreign material available. The general quotation for small or moderate lots of the 88-92 per cent material was 7½c. per lb. *Soda ash* was unchanged in price and a satisfactory volume of business was reported at $2.25 per 100 lb. for material in cooperage.

Alums were quiet, with no change reported in the list. Foreign *potash alum* was quoted at 4½@5c. per lb. for the lumps and 5½@6c. for the powder. *Sal ammoniac* was firm at 8c. per lb. for either the domestic or foreign article. *Ammonium carbonate* was in light supply on spot and what was available was held for 11@12c. per lb. *Barium chloride* was in fair request and small lots were quoted at $110 per ton. *Barium carbonate* was quiet, with only odd lots offered at $90@$95 per ton. *White arsenic* was practically off of the market, with only a few kegs available at 16@18c. per lb. *Copper sulphate* continued to move in a fair way and the price was firm at 6c. per lb. for small or moderate lots. *Carbon bisulphide* was in fair demand, but spot supplies were still light. Single drums were quoted at 7@7½c. per lb. *Carbon tetrachloride* was firm after the recent advance and 10½c. per lb. for large drums was the generally quoted price. Formaldehyde was advanced in price again due to the higher level on *methanol*. The new price was 17c. per lb. for less than 5-bbl. lots and dealers reported a fair volume of business at that figure. *Glycerine* was firm at 18½c. per lb. for the c.p. material in drums, but the movement was not very heavy.

Cyanide of potash was in poor demand, but due to the scarcity of supplies the price of 55c. per lb. was maintained. *Red prussiate of potash* was still very scarce, with only small lots available at 95c.@$1 per lb. *Permanganate of potash* was slightly easier and U.S.P. crystals were quoted for immediate delivery at 17½c. per pound.

LINSEED OIL AND TURPENTINE

Linseed oil was very quiet, with dealers reporting little or no business. The boiled oil is quoted at 93c. per gal. in single-drum lots and the raw in similar lots at 91c.

Like linseed oil, *turpentine* was very quiet, with practically nothing moving. The quotation is $1.46 per gal. for single-drum lots.

Iron and Steel Stronger Than Expected

The Usual Slump for Inventory and Holidays Has Apparently Been Avoided

PITTSBURGH, Dec. 22, 1922.

The steel market is proving stronger and more active, at this time of year, than was commonly expected. It is habitual with the market to be quiet in December, but there is on the whole a very fair turnover. As to production, in turn, buyers usually prefer shipments to be light in December, to relieve inventory, but in general steel production is maintained and of course the product is all being shipped.

FROM SELLERS' TO BUYERS' MARKET

Approximately from April 1 to Oct. 1 there was a sellers' market in steel products, at first with merely a slight stiffening in prices and afterward, as high fuel costs were fastened upon the industry, with some fairly sharp advances. In the latter part of the period deliveries were very difficult to arrange in many cases, and delivery premiums developed in several lines, including bars, shapes, plates and sheets. All such delivery premiums disappeared some time ago. Of late there has been a buyers' market in place of a sellers' market. The change has altered the aspect of market affairs so that the market has appeared quieter and with less underlying strength than has really been the case. The feature of there being a buyers' market applies to deliveries, it being possible to arrange without difficulty almost any delivery desired, except in wire products and pipe in which lines the mills are still far in arrears. There being a buyers' market does not, however, apply to prices, for steel prices are well maintained. There had been no expectation that prices of pipe, wire products, sheets or tin plate would decline, but there were many predictions, a month and more ago, that the end of the year would see a lower market on bars, shapes and plates, perhaps a 1.75c. price. The outcome, however, is that these heavy rolled products are still quotable steady at 2c. Concessions may be made occasionally, but only in exceptional circumstances, and probably to no greater extent than they were being made a month and more ago. Some large interests occupy the strategic position of having no regular or official price, so that they are free to meet price cuts at any moment, and this situation has tended to discourage other mills from cutting.

COKE AND PIG IRON PRICES

Since the buying movement in foundry iron, whereby a fairly large tonnage was put under cover for first quarter, the market has been quiet and furnaces have advanced prices. In the valley market the price is $25 furnace, and all makers are now squarely on a basis of $26 valley. Basic iron did not move to any extent, for the double reason that consumers are not so sure of their requirements in first quarter as are the foundries that bought—largely radiator and sanitary ware makers—and they have more sources from which to draw, since many if not the majority of steel interests are willing to sell basic iron. Few of them can make foundry iron to advantage. Basic has sold in two or three instances at $24.25 valley, but all makers now seem to be firm at $24.50, some of them having an asking price of $25. Bessemer has been moving in carload lots at $27.50 valley.

Connellsville coke has had a complete upset, advancing the market in the neighborhood of $3 a ton and putting it out of the reckoning with blast furnaces. The occasion was a sudden rush of buying by Eastern distributors of domestic fuel. A few thousand of tons difference in the relation between demand and supply in a week has had distinct results in making market prices. Late last week buying orders from the East appeared, in lots of 25 or 50 carloads at a time. All floating supplies were absorbed, and some prospective production as well. Early last week furnace coke was a trifle weak at $6.50, with free offerings, while this week $9 has been paid by Eastern buyers. The furnaces are nonplussed, as they were about to negotiate for first quarter supplies and expected to buy at less than the recently going spot market, $6.50@$7.

General Chemicals

Current Wholesale Prices in New York Market

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride, 85 per cent	lb.	..... –	$0.39 – $0.41
Acetone	lb.	$0.21 – $0.21½	.21½ – .22
Acid, acetic, 28 per cent	100 lb.	3.50 – 3.60	3.65 – 4.00
Acetic, 56 per cent	100 lb.	7.00 – 7.15	7.20 – 7.50
Acetic, glacial, 99½ per cent, carboys, 100 lb.		12.80 – 13.00	13.25 – 13.50
Boric, crystals	lb.	.11½ – .11¾	.12 – .13
Boric, powder	lb.	.11 – .11½	.11¾ – .12½
Citric	lb.	..... –	.50 – .52
Hydrochloric, 18 deg.	100 lb.	.80 – 1.00	1.05 – 1.20
Hydrochloric, 20 deg.	100 lb.	1.00 – 1.10	1.20 – 1.40
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – .12
Lactic, 44 per cent tech	lb.	.11 – .11½	.11½ – .12
Lactic, 22 per cent tech	lb.	.05 – .05½	.05½ – .06
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.05½ – .05¾	.06 – .06½
Nitric, 42 deg.	lb.	.06 – .06½	.06½ – .07
Oxalic, crystals	lb.	.13½ – .13¾	13½ – .14½
Phosphoric, 50 per cent solution	lb.	.07½ – .08	.08¼ – .09
Picric	lb.	.20 – .22	.23 – .27
Pyrogallic, resublimed	lb.	..... –	1.55 – 1.65
Sulphuric, 60 deg., tank cars	ton	9.00 – 10.00	..... – .....
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	..... – .....
Sulphuric, 66 deg., tank cars	ton	14.50 – 15.00	..... – .....
Sulphuric, 66 deg., drums	ton	19.00 – 20.00	20.50 – 21.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.00 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.70 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.30½ – .31
Tartaric acid, imported, powdered	lb.	..... –	.31 – .32
Tartaric acid, domestic	lb.	..... –	..... – .32
Tungstic, per lb. of WO	lb.	..... –	1.20 – 1.30
Alcohol, ethyl (Cologne spirit)	gal.	..... –	4.75 – 4.95
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.39 – .41
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.38 – .40
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½ – .03¾	.03½ – .04
Alum, chrome lump	lb.	.05 – .05½	.05½ – .06
Aluminum sulphate, commercial	100 lb.	1.50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06¾ – .07¼	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.30½ – .31
Ammonium carbonate, powder	lb.	.09 – .09½	.09½ – .10
Ammonium nitrate	lb.	.07½ – .07¾	.07¾ – .08
Amylacetate tech.	gal.	..... –	2.80 – 3.05
Arsenic, white, powdered	lb.	.15½ – .16	.16½ – .16¾
Arsenic, red, powdered	lb.	.13½ – .14	.14½ – .15
Barium carbonate	ton	75.00 – 77.00	78.00 – 80.00
Barium chloride	ton	90.00 – 92.00	93.00 –100.00
Barium dioxide (peroxide)	lb.	.18 – .18½	.19 – .20
Barium nitrate	lb.	.08½ – .08¾	.09 – .09½
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04¼	.04¼ – .04¾
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	2.25 – 2.35	2.40 – 3.50
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lb.	3.50 – 3.60	3.65 – 3.75
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	22.00 – 23.00	23.50 – 27.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.95 – .96
Carbon bisulphide	lb.	.07 – .07½	.07½ – .08
Carbon tetrachloride, drums	lb.	.10 – .10½	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05½ – .06	.06¼ – .06½
Chloroform	lb.	..... –	.35 – .38
Cobalt oxide	lb.	..... –	2.10 – 2.40
Copperas	ton	25.00 – 27.00	27.50 – 30.00
Copper carbonate, green precipitate	lb.	.20 – .20½	.21 – .22
Copper cyanide	lb.	..... –	.50 – .55
Copper sulphate, crystals	100 lb.	6.00 – 6.25	6.30 – 6.50
Cream of tartar	lb.	..... –	.25½ – .26
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ether, U.S.P. 100 drums	lb.	..... –	.13 – .15
Ethyl acetate com. 85%	gal.	..... –	..... – .....
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.15½ – .16	.16¼ – .16½
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth—imported powdered	net ton	30.00 – 32.00	..... – .....
Fuse oil, ref.	gal.	..... –	3.55 – 4.05
Fusel oil, crude	gal.	..... –	2.30 – 2.40
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c.p. drums extra	lb.	..... –	.18½ – .18¾
Iodine, resublimed	lb.	..... –	4.50 – 4.60
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate, white crystals	lb.	..... –	.12 – .12½
Lead arsenate, powd.	lb.	.20 – .20½	.20½ – .21
Lead nitrate	lb.	..... –	.18 – .22
Litharge	lb.	.09¼ – .09½	.09½ – .10
Magnesium carbonate, technical	lb.	.07 – .07½	.07½ – .08
Magnesium sulphate, U.S.P.	100 lb.	2.50 – 2.65	2.70 – 3.50
Magnesium sulphate, technical	100 lb.	..... –	1.20 – 1.85
Methanol, 95%, bbls.	gal.	..... –	1.23 – 1.25
Methanol, 97%, bbls.	gal.	..... –	1.25 – 1.27
Nickel salt, double	lb.	..... –	$0.10 –$0.10½
Nickel salt, single	lb.	..... –	.11 – .11¼
Phogene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	..... –	.35 – .40
Phosphorus, yellow	lb.	..... –	.30 – .35½
Potassium bichromate	lb.	$0.09½ – .10	.10¼ – .10½
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.10 – .10½	.11 – .15
Potassium carbonate, 80-85%	lb.	.05½ – .05¾	.06 – .06½
Potassium chlorate, powdered and crystals	lb.	.07½ – .08	.08½ – .09
Potassium cyanide	lb.	..... –	.47 – .50
Potassium hydroxide (caustic potash)	100 lb.	6.25 – 6.50	6.60 – 6.75
Potassium iodide	lb.	..... –	3.55 – 3.65
Potassium nitrate	lb.	.06½ – .06¾	.07 – .08
Potassium permanganate	lb.	.15 – .15½	.16 – .17
Potassium prussiate, red	lb.	..... –	.92 – .95
Potassium prussiate, yellow	lb.	.38½ – .39	.39¼ – .39½
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.06½ – .06¾	.07 – .07½
Salammoniac, gray, granular	lb.	.08 – .08¼	.08¼ – .08½
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	25.00 –27.00	..... – .....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.60 – 1.67	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.75 – 1.80	1.85 – 2.35
Soda ash, dense, in bags, resale	100 lb.	1.85 – 1.90	1.95 – 2.40
Sodium acetate	lb.	.07½ – .07¾	.08 – .08½
Sodium bicarbonate	100 lb.	1.75 – 1.85	1.90 – 2.30
Sodium bichromate	lb.	.07½ – .07¾	.08 – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04¾	.04¾ – .05½
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07½
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.19½ – .21	.21½ – .25
Sodium fluoride	lb.	.09 – .09½	.09½ – .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.40	3.75 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.50 – 3.60	3.65 – 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.80 – 3.90	4.25 – 4.40
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03½	.03½ – .04
Sodium nitrite	lb.	.08½ – .09	.09¼ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.20½ – .21	.21½ – .21½
Sodium silicate, (40 deg. in drums)	100 lb.	1.25 – 1.30	1.35 – 1.50
Sodium silicate, (60 deg. in drums)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.85 – .95	1.00 – 1.40
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04½ – .04¾	.05 – .05½
Sodium sulphite, crystals	lb.	.03½ – .03¾	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10½ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.50 – 3.15
Sulphur, roll (brimstone)	100 lb.	2.15 – 2.20	2.25 – 2.75
Talc—imported	ton	30.00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.10½ – .10¾	.11 – .11½
Tin oxide	lb.	..... –	.43 – .45
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15¼
Zinc chloride, gran.	lb.	.07 – .07½	.07¾ – .08
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08¼
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$0.95 — $1.00
Alpha-naphthol, refined	lb.	1.05 — 1.10
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .25
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Anthracene, 80% imported in drums, duty paid	lb.	.65 — .70
Benzaldehyde U.S.P.	lb.	1.35 — 1.40
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzene, 90%, in drums, resale	gal.	.37 — .40
Benzidine, base	lb.	.85 — .90
Benzidine sulphate	lb	.75 — .80
Benzoic acid, U.S.P.	lb.	.72 — .75
Benzoate of soda, U.S.P.	lb.	.57 — .65
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.55 — .60
Beta-naphthol, tech	lb.	.25 — .26
Beta-naphthyla mine, technical	lb.	1.00 — 1.25
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.14 — .20
Ortho-cresol, in drums (100 lb.)	lb.	.18 — .22
Cresylic acid, 97-99%, straw color, in drums	gal.	.60 — .65
Cresylic acid, 25-97%, dark, in drums	gal.	.55 — .58
Cresylic acid, 97%, resale	gal.	1.00 — 1.05
Dichlorbenzene	lb.	.07 — .09
Diethylaniline	lb.	.50 — .60
Dimethylaniline	lb.	.39 — .41
Dinitrobenzene	lb.	.20 — .22
Dinitroclorbenzene	lb.	.22 — .23
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.34 — .36
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.25 — .30
Diphenylamine	lb.	.54 — .56
H-acid	lb.	.75 — .80
Meta-phenylenediamine	lb.	.95 — 1.00
Monochlorbenzene	lb.	.08 — .10
Monoethylaniline	lb.	.95 — 1.10
Naphthalene crushed, in bbls.	lb.	.05½ — .06
Naphthalene, flake	lb.	.06 — .06½

Naphthalene, balls	lb.	$0.06½ —	$0.07
Naphthionate of soda	lb.	.58 —	.65
Naphthionic acid, crude	lb.	.60 —	.65
Nitrobenzene	lb.	.10 —	.12
Nitro-naphthalene	lb.	.30 —	.35
Nitro-toluene	lb.	.15 —	.17
N-W acid	lb.	1.20 —	1.30
Ortho-amidophenol	lb.	2.25 —	2.30
Ortho-dichlor-benzene	lb.	.17 —	.20
Ortho-nitro-phenol	lb.	.85 —	.90
Ortho-nitro-toluene	lb.	.12½ —	.14
Ortho-toluidine	lb.	.14 —	.16
Para-amidophenol, base	lb.	1.15 —	1.20
Para-amidophenol, HCl	lb.	1.20 —	1.25
Para-dichlorbenzene	lb.	.17 —	.20
Paranitroaniline	lb.	.75 —	.80
Para-nitrotoluene	lb.	.55 —	.65
Para-phenylenediamine	lb.	1.50 —	1.55
Para-toluidine	lb.	.85 —	.90½
Phthalic anhydride	lb.	.40 —	.50
Phenol, U. S. P., drums	lb.	.34 —	.35
Pyridine, domestic	gal.	1.60 —	1.75
Pyridine, imported	gal.	1.40 —	1.60
Resorcinol, technical	lb.	1.50 —	1.55
Resorcinol, pure	lb.	2.00 —	2.10
R-salt	lb.	.55 —	.60
Salicylic acid, tech., in bbls	lb.	.35 —	.37
Salicylic acid, U. S. P.	lb.	.40 —	.42
Solvent naphtha, water-white, in drums, 100 gal	gal.	.37 —	.40
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.22 —	.24
Sulphanilic acid, crude	lb.	.20 —	.22
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.35 —	.37
Toluene, in drums	gal.	.40 —	.43
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.45 —	.50
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.40 —	.42
Xylene, commercial, in tank cars	gal.	.38 —	....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax	lb.	$0.28 —	$0.30
Beeswax, refined, dark	lb.	.30 —	.32
Beeswax, refined, light	lb.	.34 —	.35
Beeswax, pure white	lb.	.39 —	.40
Candelilla, wax	lb.	.34 —	.35
Carnauba, No. 1	lb.	.39 —	.40
Carnauba No. 2, North Country	lb.	.23 —	.24
Carnauba, No. 3, North Country	lb.	.17½ —	.18
Japan	lb.	.15 —	.15½
Montan, crude	lb.	.03½ —	.04
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04 —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —	.02½
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ —	.03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.04½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05½
Stearic acid, single pressed	lb.	.09 —	.09½
Stearic acid, double pressed	lb.	.09½ —	.09½
Stearic acid, triple pressed	lb.	.10 —	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$6.25 —	....
Rosin E-I	280 lb.	6.35 —	....
Rosin K-N	280 lb.	6.45 —	$7.00
Rosin W. G.-W. W	280 lb.	7.75 —	8.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	1.39 —	1.40
Wood turpentine, steam dist	gal.	1.35 —	....
Wood turpentine, dest. dist	gal.	1.25 —	....
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	12.50
Rotor tar, bbl	500 lb.	..... —	11.00
Rosin oil, first run	gal.	.43 —	.....
Rosin oil, second run	gal.	.51 —	.....
Rosin oil, third run	gal.	.53 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		.90
Pine oil, pure, dest. dist	gal.		.85
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pine wood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags	100 lb.	3.65 —	3.75
Blood, dried, f.o.b., N. Y	unit	4.60 —	....
Bone, 3 and 50, ground, raw	ton	42.00 —	44.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate of soda	100 lb.	2.55 —	2.60
Tankage, high grade, f.o.b. Chicago	unit	4.65 —	4.75
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	4.00
Tennessee, 78-80%	ton	7.00 —	8.00
Potassium muriate, 80%	ton	35.75 —	38.50
Potassium sulphate	unit	1.00 —	.....

Crude Rubber

Para—Upriver fine	lb.	$0.25½ —	.25½
Upriver coarse	lb.	.17½ —	.17½
Upriver caucho ball	lb.	.20½ —	.20½
Plantation—First latex crepe	lb.	.27½ —	.27½
Ribbed smoked sheets	lb.	.27½ —	.27½
Brown crepe, thin, clean	lb.	.23 —	.23½
Amber crepe No. 1	lb.	.23 —	.23½

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.12 —	$0.12½
Castor oil, AA, in bbls	lb.	.12½ —	.13
China wood oil, in bbls	lb.	.12½ —	.12½
Coconut oil, Ceylon grade, in bbls	lb.	.08½ —	.08½
Coconut oil, Cochin grade, in bbls	lb.	.09 —	.09½
Corn oil, crude, in bbls	lb.	.10½ —	.10½
Cottonseed oil, crude (f. o. b. mill)	lb.	.08½ —	....
Cottonseed oil, summer yellow	lb.	.10 —	.10½
Cottonseed oil, winter yellow	lb.	.11 —	.11½
Linseed oil, raw, car lots (domestic) bbls	gal.	.90 —	.91
Linseed oil, raw, tank cars (domestic)	gal.	.86 —	.87
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.92 —	.93
Olive oil, denatured	gal.	1.05 —	1.12
Palm, Lagos	lb.	.07½ —	.07½
Palm, Niger	lb.	.07 —	.07½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12 —	.12½
Peanut oil, refined, in bbls	lb.	.13½ —	.14
Rapeseed oil, refined in bbls	gal.	.79 —	.80
Rapeseed oil, blown, in bbls	gal.	.86 —	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ —	.09½

FISH

Light pressed menhaden	gal.	$0.60 —	....
White bleached menhaden	gal.	.64 —	.65
Blown menhaden	gal.	.68 —	.69
Whale Oil, No. 1, crude, tanks, coast	lb.	.06 —	.06½

Miscellaneous Materials

Prices remain same as previous week

Ferro-Alloys

Quotations remain unchanged

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried, f.o.b. shipping points	net ton	$6.00 —	$9.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00 —	23.00
Chrome ore, 50% Cr_2O_3, c.i.f. Atlantic seaboard	ton	18.50 —	19.00
Coke, foundry, f.o.b. ovens	net ton	8.00 —	8.50
Coke, furnace, f.o.b. ovens	net ton	7.50 —	8.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	17.50 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	21.50 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.45 —	....
Manganese ore, chemical (MnO_2)	net ton	75.00 —	80.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.70 —	.75
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	lb.	.06 —	.08
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.11½ —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.11½ —	.12
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	Nominal	
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	8.50 —	8.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	7.50 —	8.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	3.50 —	3.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb.
Copper, electrolytic	14.65
Aluminum, 98 to 99 per cent	22.00 23.00
Antimony, wholesale lots, Chinese and Japanese	6.35
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00–33.00
Nickel, ingot and shot, resale	36.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	38.00
Lead, New York, spot	7.25
Lead, E. St. Louis, spot	7.05
Zinc, spot, New York	7.30
Zinc, spot, E. St. Louis	6.95

OTHER METALS

Silver (commercial)	oz.	$0.62½
Cadmium	lb.	1.15
Bismuth (500 lb. lots)	lb.	2.45
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99 per cent	lb.	1.00@1.05
Platinum	oz.	$118.00
Iridium	oz.	240.00@275.00
Palladium	oz.	60.00
Mercury	75 lb.	71.00

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MARGERUM—The Alabama Rock Asphalt Co., Florence, Ala., recently organized with a capital of $500,000, has acquired a tract of local property, consisting of about 700 acres, with extensive asphalt deposits. Plans are under way for immediate development, to include the erection of a plant for commercial production at an early date. C. W. Ashcraft is president and general manager.

BIRMINGHAM—The Lehigh Portland Cement Co., Allentown, Pa., has awarded a contract to the Bethlehem Steel Co., Bethlehem, Pa., for the construction of its proposed cement mill on site near the city, known as Tarrant City. It will have a maximum capacity of 1,000,000 bbl. per year, and is estimated to cost more than $2,000,000, including machinery.

MONTGOMERY — The Massey Concrete Products Corp., 122 South Michigan Ave., Chicago, Ill., has tentative plans under consideration for the erection of a new branch plant on local site, estimated to cost in excess of $50,000, with equipment.

Arizona

SUPERIOR—The Magna Copper Co. is arranging a fund of about $3,500,000 for extensions and improvements in its local properties. The work will include a new smelting plant with capacity for handling about 700 tons of material per day; concentrating plant with output of approximately 600 tons; and the installation of additional machinery at its copper mines.

GLOBE—The American Ores & Asbestos Co. will discontinue operations at its plant in the Sierra Ancha Mountains, near Globe, for the mining of asbestos, and will dismantle the local furnace. It is proposed to operate in another district at a later date.

PRESCOTT—The Verde Valley Fruit & Produce Association plans for the installation of a mechanical drying plant at its proposed packing house at Cottonwood, near Prescott.

Arkansas

EL DORADO—Fire, Dec. 9, destroyed a portion of the local storage and distributing plant of the North American Oil Co., with loss estimated at $200,000, including equipment and stock. It is planned to rebuild.

California

EMERYVILLE—The Paraffine Co., Inc., has purchased property adjoining its local plant, totaling about 40 acres, and plans for the erection of additions for considerable increase in capacity. Plans will be prepared at an early date.

Georgia

HAWKINSVILLE—The Ocmulgee Brick & Tile Co. has tentative plans under consideration for extensions in its plant, to include the installation of additional equipment for brick production, and expansion for the manufacture of hollow tile. It is purposed to commence work early in the spring. J. E. and O. R. Jelks head the company.

Illinois

CHICAGO—The Evans Fibre Box Co., 4734-60 South Spaulding Ave., has filed plans for the erection of a new 1- and 2-story plant, 101x127 ft., and 21x483 ft., at location noted, estimated to cost about $150,000, including equipment.

TAYLORVILLE—The Hopper Paper Co. has taken out a state charter with capital of $350,000, to build the new paper mill on local site recently announced. The company is headed by Kenneth M. Fiske and Richard Y. Hoffman. Plans for the plant are nearing completion and bids will soon be called. It will cost $65,000.

CHICAGO—The Inlander-Steindler Paper Co., 11-13 North Green St., will erect a new 4-story building on the present site, 50x120 ft., estimated to cost in excess of $45,000.

CHICAGO—Following the recent acquisition of the John J. Crooke Co., 1649 Warren Ave., manufacturer of tinfoil, by the Midland Metal Co., same address, manufacturing tin and lead foil, plans are said to be in progress for general expansion in operations. The Crooke plant will be taken over by the Midland company and continued in service, and general improvements made. The property was secured for a consideration reported at $100,000.

Indiana

CANNELTON—The Cannelton Sewer Pipe Co., manufacturer of vitrified pipe, is taking bids for the erection of a new 4-story plant addition, to be equipped for general manufacture.

FORT WAYNE—The Fort Wayne Corrugated Paper Co., Barr and Murray Sts., has plans in progress for the erection of a 2-story addition. Bids will be called at an early date. Mills, Rhines, Bellman & Nordhoff, Toledo, O., are architects.

Kentucky

LOUISVILLE—The Pfeiffer Insecticide Co. has acquired the building at Floyd and A Sts., and plans for the installation of a new plant for the manufacture of insecticides and other chemical specialties. Equipment will be installed at an early date. F. B. Ayres, manager of the Louisville Industrial Foundation, is interested in the project.

Louisiana

LAFAYETTE — John J. Kean, formerly manager of the plant of the Lafayette Salt Co., at Anse Labutte, is organizing a new company, to be known as the Star Salt Corp., and plans for the installation and operation of a new local plant. Application for a state charter will be made in the near future.

MONROE—The Monroe-Louisiana Carbon Co. has tentative plans under consideration for the construction of a new plant at Ladel, near Monroe, to cost about $250,000, including machinery.

SWARTZ—The Atlas Oil Co. has commenced the construction of a new gasoline-extraction plant on the site of its former works, to cost about $100,000. Complete refining equipment will be installed and the previous plant capacity considerably enlarged.

MONROE—The Keystone Carbon Co. has been organized with a capital of $150,000, to construct and operate a local plant for the production of carbon black and affiliated specialties, for which plans are now well under way. The plant is estimated to cost about $75,000, with equipment, and will be of 2-unit type. C. K. Williams and J. P. Ehrhart, both of Easton, Pa., are president and vice-president, respectively, of the new company.

Maryland

BALTIMORE—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., has tentative plans under consideration for the construction of a new artificial gas plant on property recently acquired in the Turner's Station district, totaling about 50 acres. The proposed plant will cost approximately $500,000. Herbert A. Wagner is president.

BALTIMORE—The Petroleum Export Co., 638 Equitable Bldg., recently organized, is planning for the construction of a new oil-refining plant on local site, estimated to cost in excess of $300,000, including machinery. Walter B. Brooks heads the company.

EASTON—At a special election, approval was given to a plan to purchase the local artificial gas plant, to be operated in the future as municipal property. Extensions and improvements are contemplated. The local Board of Public Works is in charge.

BALTIMORE — The American Oil Co., American Bldg., has filed plans for the construction of a new storage works at Hawkins Point, to include the installation of a number of steel tanks and auxiliary operating equipment.

HAGERSTOWN—The Hagerstown Lime & Chemical Co., recently organized, is planning for the installation of a new grinding and pulverizing plant on a tract of about 40 acres of lime marl property. Bids for equipment will be asked at once. The company will operate with a capital of $30,000. J. S. Myers is president.

Massachusetts

WALTHAM—The Lockwood-Bracket Co., Boston, manufacturer of soap products, is arranging for the location of its entire plant in the building at Clematis Brook, Waltham, heretofore occupied by the Motor Specialties Co., which will soon remove its works to another location. The structure will be improved and equipment installed for soap manufacture.

Michigan

IRON MOUNTAIN—The West Chapin Mining Co., recently reorganized, has work in progress on a new blast furnace at its local properties, to have an initial capacity of 100 tons per day. Other plant extensions are contemplated. J. S. Edmundson is manager.

CALUMET—In connection with a proposed merger of the Calumet & Hecla Mining Co., with a number of its subsidiaries, including the Osceola, Centennial, Ahmeek and Allouez Mining companies, plans are being considered for extensions in the different copper properties and plants, to provide for greater output.

New Jersey

CAMDEN—Fire, Dec. 13, destroyed a portion of the plant of the John R. Evans Leather Co., with loss estimated at about $25,000, including equipment. It is planned to rebuild.

BAYONNE — The Vacuum Oil Co., 61 Broadway, New York, has awarded a contract to the Turner Construction Co., 242 Madison Ave., New York, for the erection of a 2-story storage and distributing plant at its local refinery, 75x190 ft.; work will be placed under way at once.

TRENTON — The Electric Poreclain Co., New York Ave., has filed plans for the erection of a 1-story addition to its plant.

JERSEY CITY—Graham & Zenger, 104 5th Ave., New York, manufacturers and importers of crockery and chinaware, have purchased the 2-story factory at Golden and Fremont Sts., Jersey City, totaling about 10,500 sq.ft. of floor space, for a new plant. It is planned to occupy at an early date.

New Mexico

ELIZABETHTOWN — The Ideal Mining & Milling Co. has commenced the erection of a new reduction plant at its properties, to be equipped for an output of about 50 tons per day. Considerable additional equipment will be installed at the present works, including air compressor, 200-ft. steam-operated hoist and auxiliary machinery.

New York

BUFFALO—Fire, Dec. 11, destroyed a portion of the local storage and distributing plant of the Sinclair Oil Refining Co., foot of Alabama St., with loss estimated at about $25,000. Early rebuilding is under consideration.

NEW YORK—The Pan-American Petroleum & Transport Co., 120 Broadway, has plans maturing for the development of Government oil properties in California, in accordance with agreement recently made with the Naval Department, Washington, D. C., covering Naval Reserve District No. 1. The work will include plants and equipment estimated to cost in excess of $10,000,000 for the initial operations, and more than $50,000,000 for ultimate development.

Ohio

AKRON—The Crouse Clay Products Co., manufacturer of brick, has commenced the construction of an addition to its plant, designed to increase the present capacity about 25 per cent. The machinery installation will be arranged at an early date.

CLEVELAND—The city council is considering an ordinance for a bond issue of $3,380,000, the proceeds to be used for the installation of a new filtration plant at the Baldwin reservoir. A. B. Roberts, municipal utilities director, is in charge.

CAMBRIDGE—The Universal Sanitary Mfg. Co., New Castle, Pa., manufacturer of

sanitary earthenware products, has acquired the local plant of the Florentine Pottery Co., at a bankruptcy sale, for a consideration said to be $100,000. The new owner is organizing a subsidiary company to be known as the Cambridge Pottery Co., to operate the local plant for a line of sanitary products. Improvements will be made and operations resumed shortly after the first of the year. The Universal company also has plans under consideration for extensions in its New Castle works, to double, approximately, the present capacity. C. J. Kirk is president.

ZANESVILLE — The Kerns-Korsuch Glass Co., a subsidiary of the Hazel-Atlas Glass Co., Wheeling, W. Va., has commenced the construction of a new plant of tract of 137 acres of land, lately acquired for this purpose. A large portion of the new works will be given over to the development of other hollowware products than those heretofore made. Extensions and improvements will also be carried out at the present plant. To provide funds for the expansion, the company his disposed of a bond issue of $800,000, and practically the entire amount will be so utilized.

Oklahoma

OKMULGEE—The Products Gasoline Co. has plans under way for the construction of a new gasoline extraction plant on local site. W. E. Pine is president.

CUSHING—The Home Gas Co. is planning for the erection of a new 2-unit plant for the production of gasoline from casinghead gas. It will cost about $35,000.

PONCA CITY—The Marland Refining Co. has tentative plans under consideration for enlargements in its local oil refinery.

Oregon

HUNTINGTON—The Sun Portland Cement Co., recently organized with a capital of $1,000,000, will break ground at once for a new cement-manufacturing plant, to be equipped for an initial daily output of about 1,000 bbl. of material. A power house, machine shop and other buildings will also be erected. H. A. Ross is president.

Pennsylvania

EASTON—Fire, Dec. 13, destroyed a portion of the local plant of the General Chemical Co., known as the West Easton Works, with loss approximating $22,000. It is planned to rebuild.

PHILADELPHIA — The Royal Veterinary Products Co. has leased property at 3041 Salmon St., for the establishment of a local works for the manufacture of chemical specialties. Immediate occupancy is being arranged.

PITTSBURGH—The Night Hawk Peninsular Mines, Ltd., James R. Dodworth, 323 4th Ave. (Pittsburgh-Hanover Coal Co.), chairman of the board, has plans under way for extensions and improvements in its plant and properties in the Porcupine district. A new mill will be constructed for metal reduction, with electric power plant and other mechanical buildings. To provide funds for the expansion, the company is disposing of a stock issue of $300,000.

SUSCON—Fire, Dec. 9, caused by an explosion, destroyed a number of buildings at the local plant of the Black Diamond Powder Co. It is said that the loss included one of the main mills. An official estimate of loss has not been made.

Tennessee

CHATTANOOGA—Gregg & Co., 165 Broadway, New York, engineers, have plans in progress for the construction of a new reduction plant on local site, for a company now being organized. The plant will be used for the grinding and pulverizing of non-metallic ores, including kaolin, feldspar, mica, limestone and affiliated specialties. It will have an initial production of about 50 tons per day and is estimated to cost approximately $100,000. Arrangements for equipment will be perfected soon.

Texas

PALESTINE — The Ligol Chemical Co., Houston, has acquired the lignite properties of the Anderson County Coal Co., near Palestine, and plans for the erection of a new plant for dehydrating work, including byproducts coal production. A feature will be made of the production of carbon. It is planned to commence operations at an early date.

ORANGE—The Port Vernon Oil Co. is said to be planning for the rebuilding of the portion of its local oil-refining plant, recently destroyed by fire. New equipment will be installed.

Industrial Developments

OIL—The Standard Oil Co. is increasing production at its Bayway refining plant, Elizabeth, N. J., and adding to the working force. Employment is being given to 3,000 men, or approximately the normal quota. More than 100 men have been added to the force since the first of the month.

The Haskell Oil Co. has completed a new refinery at Sigler, near Vernon, Tex., and will soon place the unit in service on a capacity basis, or about 100 bbl. of crude oil per day. This is the first oil-refining plant to locate in this district, and will be devoted to straight-run gasoline, as well as fuel oil and kerosene.

The Simms Petroleum Co. is increasing operations in the Smackover, Ark., field, and adding to its storage plant. It is proposed to develop the tankage to a maximum of 4,100,000 bbl.

The Mexico Oil Co. is planning for an early resumption of operations at its properties in the San Miguel, Mexico, district.

The National Products Co. is advancing operations at Terlton, Okla., and will soon commence the installation of a new 3-unit casinghead gasoline plant.

CEMENT—The Coplay Cement Mfg. Co., Coplay, Pa., has closed its local mill for the holidays for necessary repairs to equipment. It is proposed to resume production on Jan. 2 on a full-capacity basis.

Cement mills in the Lehigh Valley section of Pennsylvania are continuing operations at a maximum schedule. The annual shutdown periods at this time for machinery repairs will be deferred at 90 per cent of the mills, and it is not expected to curtail until plant conditions absolutely necessitate.

The Alpha Portland Cement Co. is maintaining full production at its La Salle, Ill., mill and will continue on this basis for an indefinite period. A full working force is employed. Work is in progress on additional storage at the plant, comprising a reinforced-concrete structure, 70x125 ft.

Cement mills at Birmingham, Ala., and vicinity are holding to a capacity schedule, with normal working forces. The plants are closing the best and biggest year in their history. Alabama mills have produced and sold close to 50 per cent of the 5,500,000 bbl. manufactured in the South in 1922. The largest mill in the state has shipped 1,500,000 bbl. during the last 12 months, this being the Atlas Portland Cement Co., at Leeds.

CERAMIC—About 170 potters have returned to the plant of the H. P. Wyllie China Co., Huntington, W. Va., as a result of the termination of the strike, and production at the pottery has been resumed.

The Summit China Co., Akron, O., has reopened its pottery on a full-production basis, following the return of 250 men who have been out on strike.

Lenox, Inc., Trenton, N. J., manufacturer of high-grade chinaware, has announced that the plant will be conducted as an open shop in the future. Only a portion of the men recently out on strike will be reemployed by the company.

The 10 weeks' strike in the general ware branch of the pottery industry, just closed, is estimated to have lost from 600 to 700 kilns of glost and bisque ware valued at $2,000 to $2,500 a kiln, and from 2,800 to 3,000 decorating kilns of varying valuation. The loss in wages is officially stated at $1,500,000, and with the estimated production loss, the total is $5,000,000.

IRON AND STEEL—The Alliance Steel Co. is planning for immediate operations at its new mill at Ottawa, Ill., comprising the former plant of the Central Steel Co.; it has been inactive for more than 8 years past. Production will be on a basis of 1,200 tons per month. The working force is being recruited.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., a subsidiary of the United States Steel Corp., is running full at its Ensley furnaces, giving 100 per cent production of pig iron.

The Witherbee, Sherman Co., New York, is making improvements at its blast furnace at Port Henry, N. Y., including the installation of a new skip hoist. It is expected to have the unit ready for blowing in late in February. Shortly thereafter, in April, the new 400-ton furnace now being built at the plant will be ready, giving a total production of 750 tons per day for the two stacks.

The Thomas Steel Co. has 6 of its 12 mills in service at the Mahoning Valley works, near Niles, O.

The Gulf States Steel Co., Birmingham, Ala., is running full at its mills, and will maintain this schedule for an indefinite period. Employment is being given to a normal working force.

The American Steel & Wire Co. has resumed operations at its mill at Anderson, Ind., following a shut-down of about 4 months. Employment will be given to approximately 400 men in the different departments.

METALS—The Butte Copper & Zinc Co., Butte, Mont., is operating on a basis of 250 tons per day, and plans to bring this output up to an average of 300 to 400 tons daily at an early date.

The Wolverine Copper Co., Calumet, Mich., is developing a production of about 900 tons per day, and purposes to increase this in the near future.

The Ray-Hercules Mines Co., Ray, Ariz., is making ready to place its new mill in service at an early date. The plant has been constructed in three units, with rated daily output of 600 tons per unit. Only one unit will be run at the present time, the others to be held ready for operation when required.

The American Zinc Co. is planning to place the new mill in service at its Silver Dike, Mont., property late in January. The plant is nearing completion, and has a rated output of 450 tons per day. The company will extend its zinc-oxide production, and has commenced improvements at its plant for this purpose.

MISCELLANEOUS—The United States Industrial Alcohol Co. will reopen its Peoria, Ill., plant at once. A full working force will be employed to develop 100 per cent capacity.

The Dunlop Tire & Rubber Corp. of America, Buffalo, N. Y., is arranging for the early reopening of its large plant on the River Road, which has been inactive for a number of months past. About 5,000 workers will be employed for initial production, and this force will be increased to 10,000 men and women at an early date.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE is holding a meeting Dec. 26 to 30 in Boston, Mass.

AMERICAN CERAMIC SOCIETY will hold its annual meeting in Pittsburgh, Pa., Feb. 12 to 17, 1923.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting May 3, 4 and 5, 1923, at the Commodore Hotel, New York City.

AMERICAN ENGINEERING COUNCIL, executive organ of the Federated American Engineering Societies, will meet in Washington, D. C., Jan. 11 and 12, 1923.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its annual meeting in New York City during the week of Feb. 19, 1923.

AMERICAN SOCIETY FOR STEEL TREATING will hold its winter sectional meeting in the City Club, Chicago, Feb. 15 and 16, 1923.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

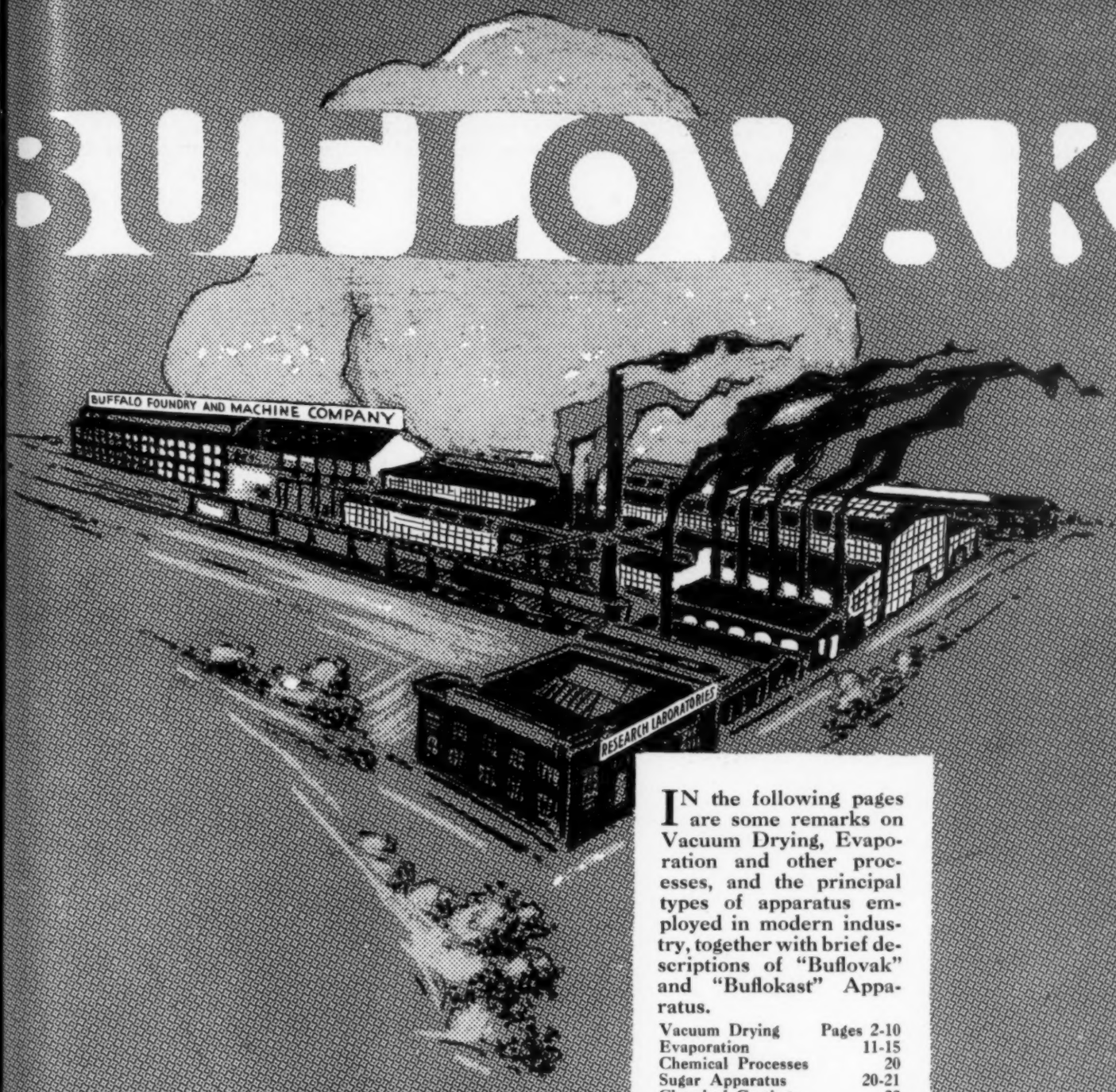
NATIONAL FOREIGN TRADE COUNCIL will hold its annual conference April 25, 26 and 27, 1923, in New Orleans, La.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS, with headquarters in Chicago, will hold its spring convention in Cincinnati, April 18, 19 and 20, 1923. The major subject will be "Management Problems of the Smaller Plants."

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, East 41st St., New York City: Jan. 5 — American Chemical Society, regular meeting. Jan. 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.

BUFLOVAK



IN the following pages are some remarks on Vacuum Drying, Evaporation and other processes, and the principal types of apparatus employed in modern industry, together with brief descriptions of "Buflovak" and "Buflokast" Apparatus.

Vacuum Drying	Pages 2-10
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BUFLOKAST

Buffalo Foundry & Machine Company

Vacuum Drying

As an Aid to Greater Industrial Efficiency

THE art of drying has engaged the attention of mankind from time immemorial. Primitive man probably learned at a very early age to preserve his food by drying it and thus tide him over from one period of plenty to another. In later periods came the drying of many other materials; and today drying is a well defined step in many manufacturing processes.

Considering early advancement in other lines of endeavor, it is a remarkable fact that only within recent years has drying been placed on the scientific and practical basis that enables it today to keep pace with and anticipate the growing needs of industrial efficiency.

Vacuum Drying

Early methods of drying were crude in the extreme. Exposing materials to be dried to air under ordinary temperatures, ever subject to contamination and unknown variations, proved slow, incomplete, costly and unsafe. As the science of drying has developed, such practices have become obsolete. Today VACUUM DRYING enables manufacturers to dry their materials with a degree of safety, certainty and economy of time and labor hitherto little hoped for.

Safety

The SAFETY of vacuum drying lies in the fact that materials can be dried under vacuum at much lower temperatures than is possible under atmospheric conditions. When drying under atmospheric conditions it is necessary to raise the temperature of the material to 212° Fahr. (the boiling point of water) in order to vaporize the moisture contained in the material. With vacuum drying, the boiling or vaporizing point can be kept down to any required temperature, some delicate materials being dried where necessary at temperatures around 75° Fahr., the vaporizing point of the moisture depending on the height of the vacuum maintained in the dryer. This then removes all danger of overheating. Vacuum drying is also safe because there is no danger of contamination, such as is possible where currents of heated air pass over the material. Another difficulty encountered in atmospheric drying is oxidation. For the same reason mentioned above,—namely, the absence of air in the dryer, oxidation does not take place in the vacuum dryer.

Certainty

The CERTAINTY of vacuum drying lies in its positive character. Drying is accomplished at a pre-determined temperature, which is practically under absolute control at all times.

With the absence of air, the drying is independent of atmospheric or climatic conditions. Consequently changes in humidity and other atmospheric variations do not effect the uniformity of the dry material as it leaves the dryer.

Economy

Vacuum drying is ECONOMICAL because of its quick drying time. Materials give us their moisture much more rapidly under vacuum, and are now being dried in a fraction of the time formerly required. In some cases, a few hours now accomplishes what formerly required days, and even weeks. Stocks of materials formerly carried on hand or in process of drying are thus materially reduced. Other economies effected are less floor space required, and lower labor, fuel and power costs per unit of dried product.

Extensively Used

Vacuum dryers have been used so extensively in drying a great variety of products, that to give a complete list would require more space than is here available. However, a few of the general lines may be named as follows:

Food Products
Chemical Products
Drugs
Pharmaceuticals
Fruits and Vegetables
Cereal Products
Grain
Crude Rubber
Reclaimed Rubber
Various products used in rubber industry
Rare Earths
Bakers' Supplies
Mfg. Confectioner's Supplies
Milk and other Dairy Products
Packing House Products and various By-Products
Photographic Materials
Cottonseed and other Vegetable Products
Leather Goods
Paper and Pulp
Tobacco
Fertilizers
Sugar
Beverage Extracts
Canned and Dried Fruits
Electrical Goods
Coffee, Tea and Spices
Salt
Paints, Dyes, Varnishes
Soaps
Brewers' Materials
Various other edible products not listed above
Tanning and Dyewood Extracts

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Vacuum Drying—Continued

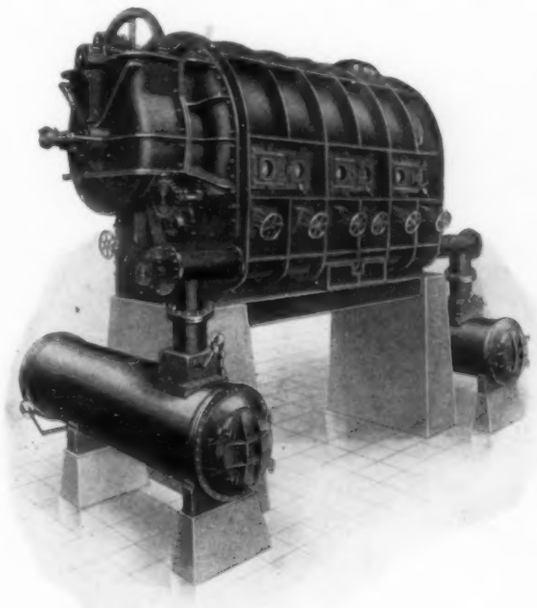
Three Types of Dryers

Materials that usually require drying may be separated into three groups, each group having its own type of dryer. In the first group are included liquids of all sorts. The second group contains those materials that must be spread out in flat pans or trays while being dried. The third group includes those materials that require or are assisted by agitation during the drying process. The three types of "Buflovak" dryers corresponding to these three groups of materials are as follows:—

"Buflovak" Vacuum Drum Dryer—for drying liquid solutions containing solids.
"Buflovak" Vacuum Shelf Dryer — for materials that must be handled in pans or trays.
"Buflovak" Vacuum Rotary Dryer—for materials that permit agitation or mixing.

"Buflovak" Vacuum Drum Dryer

For Drying Liquids



"Buflovak" Vacuum Drum Dryer, arranged for continuous operation

This dryer consists of a vacuum chamber with a hollow heated revolving drum, and is equipped with devices for applying the liquid to the drum and removing the dry material. The line drawing on the next page shows the method of operation. The liquid to be dried is pumped from the bottom of the casing to the pan under the drum. The drum, as it revolves, receives a coating or thin film of liquid, the thickness being regulated by a device called a spreader, which also breaks up any bubbles, and leaves only a uniform coating of any desired thickness. By the time the material reaches the knife or scraper, which removes it, the moisture has evaporated and the material is removed from the drum in a dry state.

Outstanding Features

AMONG the outstanding features of this apparatus for converting liquids into dry form are (1) Solubility of dry product. (2) Uniformity of dry product. (3) High yield. (4) Cleanliness. (5) Quick drying time. (6) Low cost of operation.

Solubility. Overheating destroys or decreases the solubility of many dry products when converted from a liquid state. This is absolutely avoided with this dryer because the apparatus operates under a high vacuum and consequently the material is always kept at a low temperature.

Uniformity. By our patented system of controlling the liquid supply a uniform coating is assured, thereby resulting in a uniform dry product. As the drying is done under vacuum, the uniformity of the dry product is not affected by changes in humidity or other atmospheric variations.

High Yield. The "Buflovak" dryer gives the highest possible yield in dry product from each gallon of liquid. No solids can escape with the vapor. Consequently there is no loss of solids from the original liquid to the dry product.

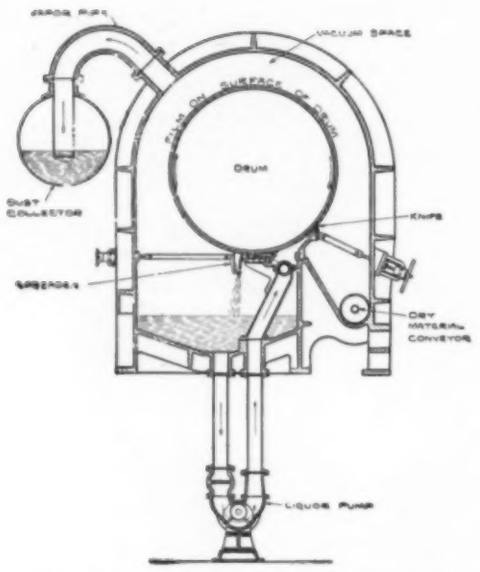
Cleanliness. The dryer is so constructed that all parts of the interior are easily reached and can be thoroughly cleaned.

Quick Drying Time. The material is converted continuously from a liquid state to a dry state in less than one revolution of the drum, requiring only a few seconds of time on most materials.

Low Cost of Operation. Owing to the high capacity of the dryer, the small amount of labor, fuel and power required, the cost of producing dry material is surprisingly low, some liquids having been dried at a cost under one-tenth of a cent per pound, this cost including depreciation, interest on investment, steam, power, labor and other incidentals.

Buffalo Foundry & Machine Company

Vacuum Drum Dryer—Continued



Cross-Section of "Buflovak" Vacuum Drum Dryer showing interior arrangement

applying the liquid to the drum that overcame these difficulties, and made possible the attainment of satisfactory commercial results with this type of dryer. These patented features are obtainable only in "Buflovak" equipment. Foaming, viscosity or other characteristics of the liquid do not affect the drying or the quality of the dry product, because the drum is entirely clear of the body of liquid, as shown by the drawing.

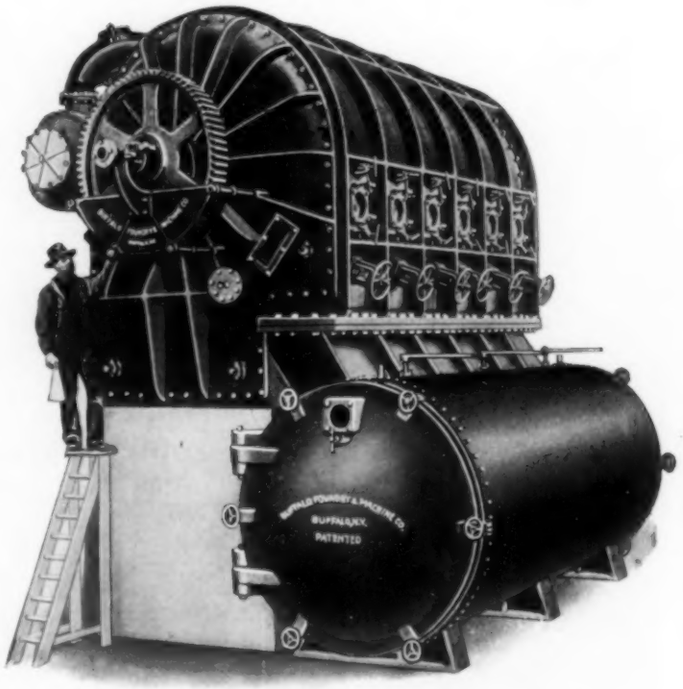
"Buflovak" Vacuum Drum Dryers are today used for drying solutions, emulsions, pulps, and all liquids containing solids. They are saving time and money in efficiently drying many materials without danger of overheating or other injury. Your high drying costs may be due to the lack of just this type of equipment.

"Buflovak" Patented Devices

The Vital Elements of Successfull Operation

While the vacuum drum dryer process was long recognized, in theory, as the ideal method of drying liquids, it failed to give satisfactory results on account of the difficulties encountered by foaming of the liquid under vacuum, which prevented a uniform coating on the drum. Where the drum dips or is partly submerged in the main body of the liquid it is impossible to maintain a constant level due to the oscillation and ebullition that takes place. This change in level makes a corresponding change in the amount of drum surface dipping in the liquid and results in an uneven coating on the drum and a lack of uniformity in the dry product.

It was the application of our patented devices for controlling the liquid supply and



"Buflovak" Vacuum Drum Dryer with single receiver, for materials that cannot be mechanically conveyed

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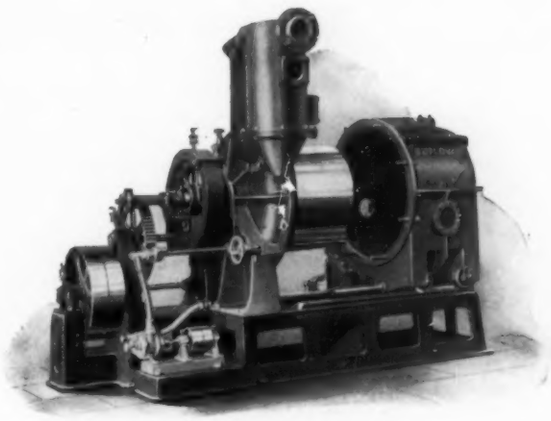
"Buflovak" Vacuum Drum Dryer
No. 1 Size

DESIGNED for drying smaller quantities of liquids than can be handled economically in the larger sizes. Also makes an efficient laboratory dryer. The casing is moved away from the drum to give access for cleaning. Otherwise it operates the same as the larger sizes.



No. 1 Vacuum Drum Dryer

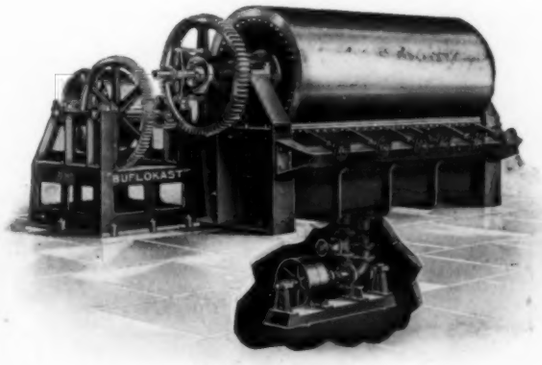
STANDARD SIZES OF VACUUM DRUM DRYERS

No.	Diameter of Drum	Length of Drum	Weight	Approximate Outside Dimensions		
				Length	Width	Height
1	24"	20"	16,000 pounds	10′	8′	8
2	48"	20"	32,000 "	18′	10′	12
3	48"	40"	44,000 "	18′	12′	12′
4	60"	72"	70,000 "	20′	24′	18′
5	60"	144"	100,000 "	20′	30′	18′

Weights include complete apparatus and are approximate. Vacuum Pump and Condenser not included in above space. Apparatus is usually equipped with barometric condenser. Will furnish surface condenser if desired.

SPECIAL SIZES BUILT FOR SPECIAL CONDITIONS

Atmospheric Drum Dryers



Used for drying liquids that do not require a vacuum. Embodies the patented principles and devices of the vacuum type. The storage or reserve tank is made in one piece, thus removing all danger of leakage through part becoming loose or disconnected.

Vacuum Shelf Dryers For Materials that Must be Dried in Pans or Trays

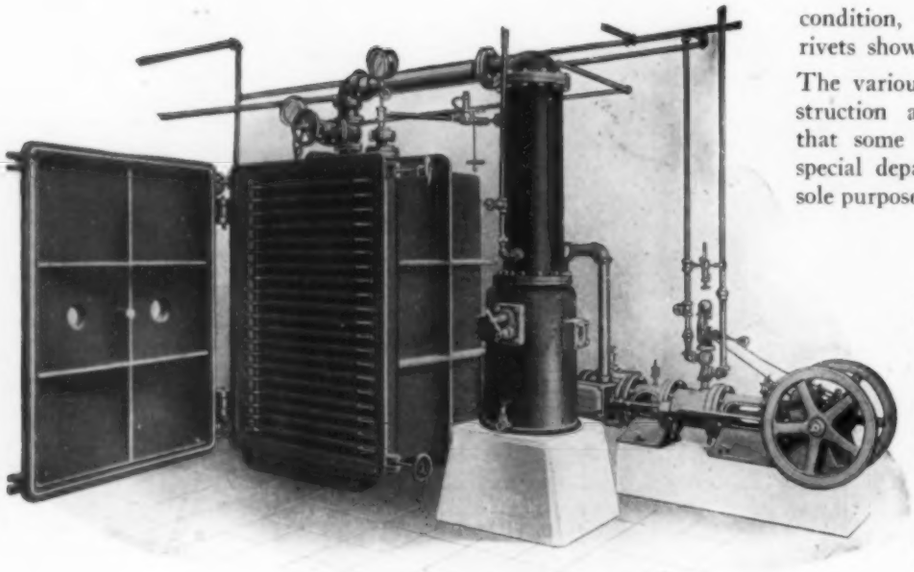
The second group of materials includes those which must be spread out in flat pans or trays while being dried. For such materials the most suitable type is the vacuum shelf dryer. This dryer consists of a vacuum chamber containing a series of shelves on which the loaded pans or trays of material are placed. The shelves are hollow and may be heated by steam or hot water depending on the maximum temperature permitted in handling the particular material being dried.

Substantially Built

The construction of the "Buflovak" Shelf Dryer provides a heavy substantial and durable equipment. The cast iron used is that quality known as "gun-iron" which is far more dense and has a higher

Buffalo Foundry & Machine Company

Vacuum Shelf Dryer—Continued

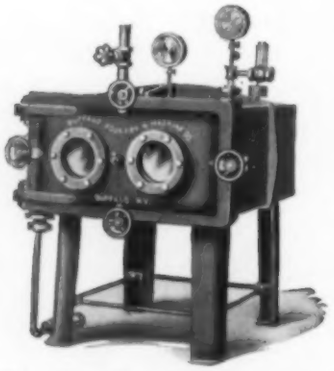


"Buflovak" Vacuum Shelf Dryer

tensile strength than ordinary cast iron. The chamber body casting is made in one piece, rendering unnecessary many joints which would otherwise be required, and avoiding the troublesome air leakages which such joints cause.

Shelf Construction

The heating shelves are made of steel plates joined together by seamless weld. Great care is taken in making the shelves, so that they will be perfectly level, and have a flat even surface when placed in the chamber. Otherwise the bottom of the pan containing the material will not come in actual contact in some places with the heating surface of the shelf and, due to the vacuum, practically no heat can be transmitted to the material at such points of non-contact. As further assistance in keeping the shelf in proper condition, note the large number of rivets shown in the illustration.

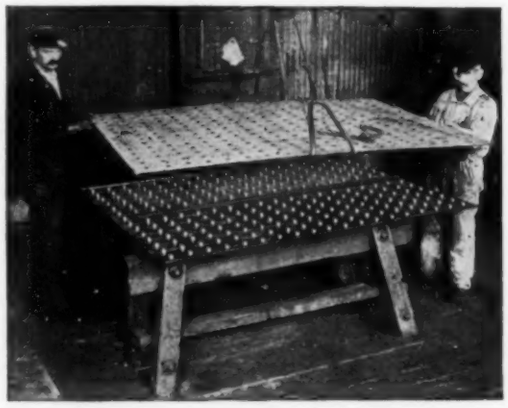


Size C-4—Note large observation glasses for observing interior during operation

The various features of our shelf construction are considered so important that some years ago we established a special department in our plant for the sole purpose of manufacturing shelves.

Manifolds

A serious difficulty with shelf dryers improperly constructed is the trouble caused by the strain on the manifold due to the expansion and contraction of the shelves, which frequently breaks the connecting joint and even the manifold itself. To overcome this difficulty our manifolds are made of XX steel pipe, which prevents breakage, and each manifold is held at only one end instead of being fixed at both ends. This leaves the other end of the manifold free to swing and permits the free expansion and contraction of of the shelves without throwing a strain on the pipe connections between the shelves and manifold. Our manifold construction does away with all gaskets and flanged connections. This is accomplished by the use of ground joints in the union connection between the manifold and shelves. The manifold faces outward, so that a shelf can be readily disconnected at any time.



Plates for Dryer Shelves, showing spacing blocks and rivets. Note large number used.

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Vacuum Shelf Dryer—Continued

Some Uses of Vacuum Shelf Dryers

"Buflovak" Vacuum Shelf Dryers are adapted to the drying of a great variety of products including sheet and reclaimed rubber of all kinds, rubber compounds, paints, dyes, extracts, pastes, glues, soap, salts, albumens of all descriptions, starch, glutrin, rosin, vegetables, fruits, sugars, small electrical apparatus, plates, chemicals, various by-products and a great number of food products of various description.

"Buflovak" Vacuum Shelf Dryer loaded for shipment. Weight about 47,000 lb. Note the one-piece construction of the chamber casting

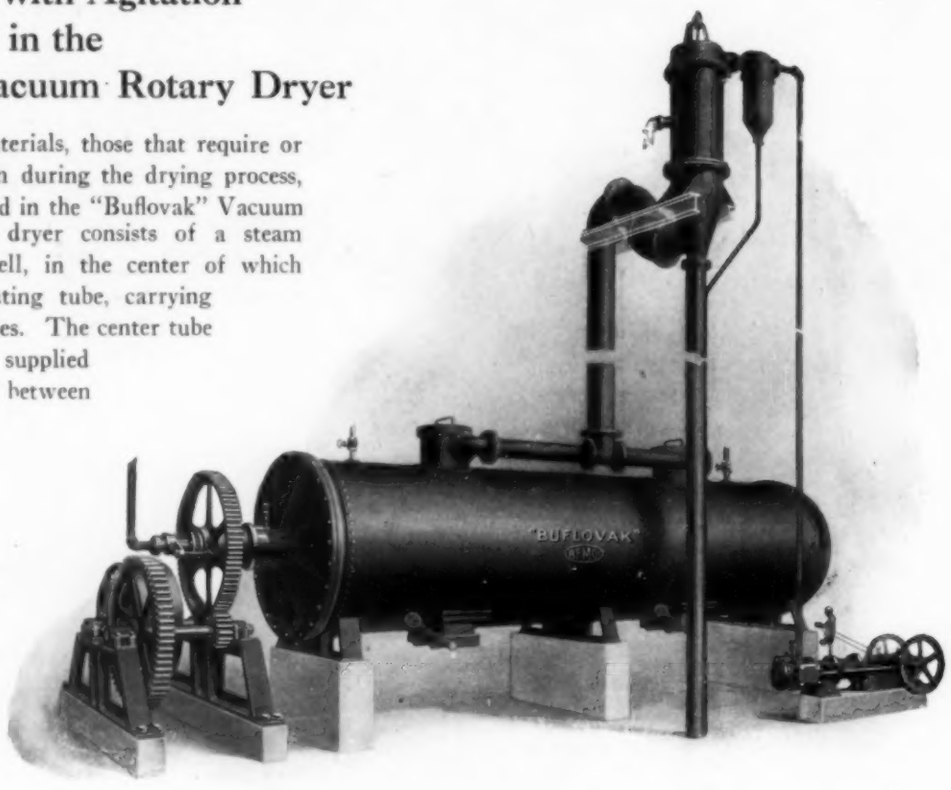
"Buflovak" Vacuum Shelf Dryers—Standard Sizes

Number of Dryer	Quantity of Shelves	Width of Shelf, Inches	Length of Shelf, Inches	Space between Shelves, Inches	Total Pan Surface in Dryer, Sq. Ft.	Approximate Heating Surface in Dryer	Inside Height of Dryer, Inches
A1	1	18	18	4½	2¼	5	4½
B2	2	24	24	5½	4	19	11½
B3	3	"	"	2⅜	8	29	"
C3	3	42	42	6½	22	78	21
C4	4	"	"	4½	33	104	"
C5	5	"	"	3⅜	44	131	"
C6	6	"	"	2½	55	157	"
D6	6	42	42	5	55	157	35¼
D7	7	"	"	4	66	183	"
D8	8	"	"	3½	77	209	"
D9	9	"	"	2⅞	88	235	"
D10	10	"	"	2½	99	261	"
E8	8	42	42	6	77	209	54¼
E9	9	"	"	5	88	235	"
E10	10	"	"	4½	99	261	"
E11	11	"	"	4	110	287	"
E12	12	"	"	3⅝	121	313	"
E13	13	"	"	3	132	339	"
E15	15	"	"	2⅜	154	392	"
F11	11	42	42	5½	110	287	70⅜
F12	12	"	"	5	121	313	"
F13	13	"	"	4½	132	339	"
F14	14	"	"	4	143	365	"
F16	16	"	"	3⅜	165	413	"
F17	17	"	"	3	176	444	"
F20	20	"	"	2½	209	522	"
G9	9	60	80	5⅜	240	617	56¼
G10	10	"	"	4½	270	685	"
G11	11	"	"	4⅛	300	754	"
G12	12	"	"	3⅝	330	822	"
G13	13	"	"	3¼	360	891	"
G14	14	"	"	2⅞	390	959	"
G15	15	"	"	2⅝	420	1,028	"
G16	16	"	"	2⅜	450	1,096	"
H9	9	60	120	5⅜	360	923	56¼
H10	10	"	"	4½	405	1,025	"
H11	11	"	"	4⅛	450	1,128	"
H12	12	"	"	3⅝	495	1,230	"
H13	13	"	"	3¼	540	1,333	"
H14	14	"	"	2⅞	585	1,435	"
H15	15	"	"	2⅝	630	1,538	"
H16	16	"	"	2⅜	675	1,640	"
I 9	9	60	160	5⅜	480	1,232	56½
I 10	10	"	"	4½	540	1,369	"
I 11	11	"	"	4⅛	600	1,510	"
I 12	12	"	"	3⅝	660	1,643	"
I 13	13	"	"	3¼	720	1,780	"
I 14	14	"	"	2⅞	780	1,917	"
I 15	15	"	"	2⅝	840	2,054	"
I 16	16	"	"	2⅜	900	2,190	"
J12	12	60	80	5	330	823	72
J13	13	"	"	4½	360	892	"
J14	14	"	"	4	390	960	"
J16	16	"	"	3½	450	1,098	"
J18	18	"	"	3	510	1,235	"
J19	19	"	"	2⅞	540	1,303	"
J20	20	"	"	2½	570	1,372	"
K12	12	60	100	5	412½	1,027	72
K13	13	"	"	4½	450	1,113	"
K14	14	"	"	4	487½	1,198	"
K16	16	"	"	3½	562½	1,370	"
K18	18	"	"	3	637½	1,541	"
K19	19	"	"	2⅞	675	1,626	"
K20	20	"	"	2½	712½	1,712	"
L12	12	60	120	5	495	1,230	72
L13	13	"	"	4½	540	1,333	"
L14	14	"	"	4	585	1,435	"
L16	16	"	"	3½	675	1,640	"
L18	18	"	"	3	765	1,845	"
L19	19	"	"	2⅞	810	1,948	"
L20	20	"	"	2½	855	2,050	"
M12	12	60	140	5	577½	1,430	72
M13	13	"	"	4½	630	1,550	"
M14	14	"	"	4	682½	1,669	"
M16	16	"	"	3½	787½	1,907	"
M18	18	"	"	3	892½	2,146	"
M19	19	"	"	2⅞	945	2,265	"
M20	20	"	"	2½	997½	2,384	"
N12	12	60	160	5	660	1,643	72
N13	13	"	"	4½	720	1,780	"
N14	14	"	"	4	780	1,917	"
N16	16	"	"	3½	900	2,190	"
N18	18	"	"	3	1,020	2,464	"
N19	19	"	"	2⅞	1,080	2,601	"
N20	20	"	"	2½	1,140	2,753	"

Buffalo Foundry & Machine Company

Drying with Agitation in the "Buflovak" Vacuum Rotary Dryer

The third group of materials, those that require or are assisted by agitation during the drying process, are most efficiently dried in the "Buflovak" Vacuum Rotary Dryer. This dryer consists of a steam jacketed cylindrical shell, in the center of which revolves a hollow heating tube, carrying arms and stirring paddles. The center tube and outer jacket are supplied with steam. The space between the center tube and steam jacket is the vacuum chamber and contains the material to be dried. The revolving paddles keep the material being dried in constant motion so that it comes in frequent contact with the heating surfaces until sufficiently dry.



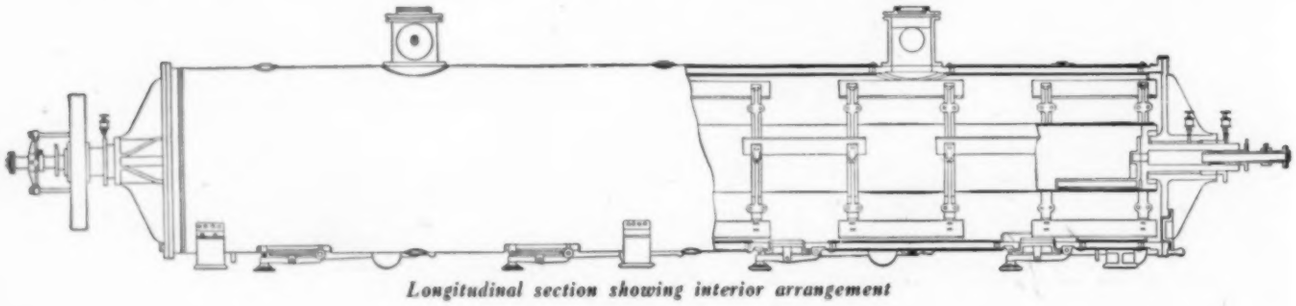
Improved Construction

The "Buflovak" construction is designed to give a high degree of efficiency. Instead of the ordinary welded or riveted steel plate construction, we use lap-welded steel tubing for both the outer jacketed shell and inner revolving tube. This construction being "truer to a circle" and free from joints and rivets permits the paddles to be placed closer to the wall of the dryer and greatly increases its efficiency.

Products Handled

The materials handled in this dryer include many liquids, and semi-liquids, solids in granular form, starch and other cereals, various by-products, fertilizers, dextrine, reclaimed rubber, rubber compounds, etc. Cooking or digesting operations, where required, can be performed in the same apparatus before creating the vacuum, thus saving handling.

An important advantage when drying fertilizers, packing house by-products and similar materials, is that the surrounding atmosphere does not become contaminated with obnoxious odors. The dryer can be so arranged that little labor or operating expense is required.



Longitudinal section showing interior arrangement

1543 Fillmore Avenue, Buffalo, New York

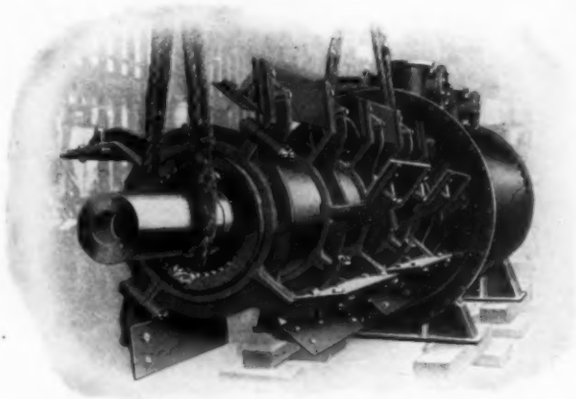
"Buflovak" Vacuum Rotary Dryer

TABLE OF STANDARD SIZES

Size	Inside Diameter	Inside Length	Approximate Outside Dimensions			Approximate Weight
			Length	Width	Height	
R-1	2′	4′	7′	4′	5′	1,800 lbs.
R-2	3′	6′	10′	7′	8′	10,500 "
R-3	3′	10′	14′	7′	8′	14,500 "
R-4	3′	15′	19′	7′	8′	19,000 "
R-5	3′	20′	25′	7′	8′	24,000 "
R-6	5′	10′	17′	10′	11′	23,000 "
R-7	5′	15′	22′	10′	11′	30,000 "
R-8	5′	20′	28′	10′	11′	38,000 "
R-9	5′	25′	33′	10′	11′	46,000 "
R-10	5′	30′	39′	10′	11′	55,000 "

Special sizes built to order.

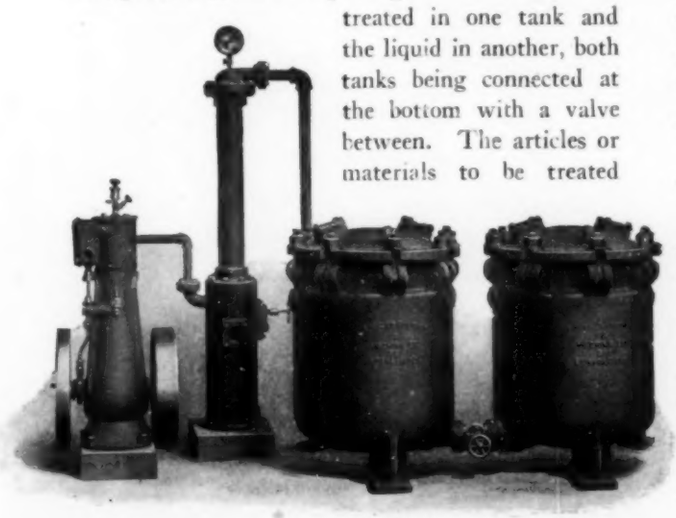
Weights given are for steel plate construction. Also built with cast iron shell. Above outside dimensions allow for a foundation of sufficient height to open the unloading doors between the floor and the bottom of the dryer except the 2′ x 4′ size, which is placed on cast-iron stands of the proper height to open the unloading doors.



Arrangement of arms and paddles on center heating tube of "Buflovak" Vacuum Rotary Dryer

Vacuum Drying and Impregnating

Besides the three types of dryers described above there is another type of apparatus which is a combination of dryer and impregnator. This is used for impregnating under pressure various articles and materials with a liquid solution. Some of the materials so treated consist of electric coils, cables, transformers, armatures, and other electrical apparatus which are impregnated with insulating compounds; a great variety of materials are impregnated with paraffine, creosote, oils, colors, waterproofing compounds, etc.; wood and similar articles are treated with stains or colors in order to make imitations of other woods such as mahogany, cedar, etc. The process consists of placing the materials to be treated in one tank and the liquid in another, both tanks being connected at the bottom with a valve between. The articles or materials to be treated are first dried under vacuum. After the air and moisture are removed from the pores of the material, the liquid is admitted into the tank and forced into the evacuated pores under pressure until they are thoroughly filled. The liquid is then forced back into the other tank and the valve closed between the tanks. The impregnated articles can then be taken out or if necessary redried under vacuum. Any solvent used in this work may be recovered if desired. This apparatus is built in many sizes.



"Buflovak" Vacuum Drying and Impregnating Apparatus

"Buflovak" Vacuum Accessories

A factor of considerable importance that has contributed much to the success of "Buflovak" vacuum drying apparatus, is the efficiency of the accessories furnished with our dryers, particularly the vacuum pump and condenser.

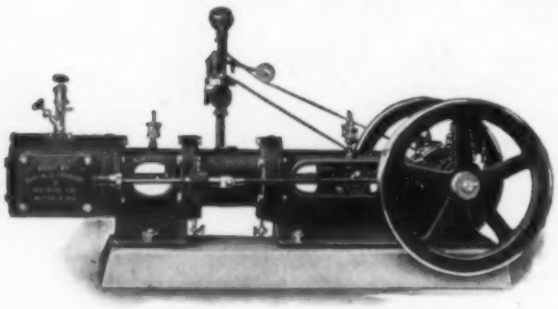
"Buflovak" Dry Vacuum Pumps

An important difference between our pump and some other types is in the valve construction. Instead of the rotary valve so commonly used we use a plain slide valve. This valve operates or slides on a seat which tapers inward toward the cylinder ports. The tapered seat acts as a guide and keeps the valve against the ports. The valve is therefore self-seating and automatically compensates for the wear that takes place.

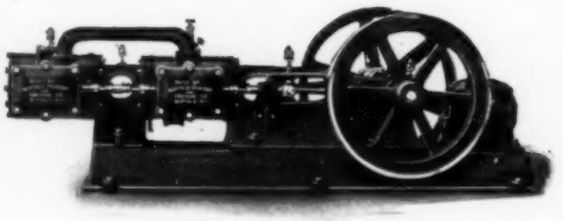
With the rotary valve it is practically impossible

Buffalo Foundry & Machine Company

"Buflovak" Dry Vacuum Pumps—Continued



Single Stage—Steam Driven

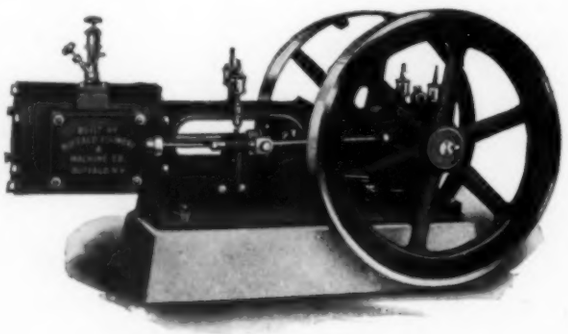


Two Stage—Motor Driven

to make the same provision for compensation as in the slide valve, and consequently, a pump so equipped decreases in efficiency in proportion to the wear of the valve.

In place of the old style troublesome poppet exhaust, we provide an exhaust valve of distinctive design consisting of a metal breathing plate, so attached to the air valve that the ends of the plate covering the exhaust ports are free and have sufficient flexibility to permit the air from the cylinder to escape with each stroke of the piston.

The air valve may be removed from the air chest in a few moments by simply taking off the air chest cover and lifting out the valve, there being no attachments to be released. This makes it a simple matter to scrape the ports when necessary, and they can be worked down to a close fit in a few moments. "Buflovak" Dry Vacuum Pumps are designed for high efficiency under all conditions, but especially for exacting service where the attainment of an extra quarter or half inch of vacuum may be of great importance. They are built in many sizes, single and two-stage, for operation with belt, steam or motor.



Single Stage—Belt Driven

Barometric Condenser

"Buflovak" Condensers

An essential part of every vacuum drying installation is the condenser. The type depends on the quantity and value of the vapors to be handled. The surface condenser is provided where the quantity is small, or where the condensed vapor is to be recovered. This condenser is so arranged that the receiver can be drained at any time without disturbing the operation.

For handling large quantities of vapor which have no commercial value and which may be mixed with the cooling water, a barometric condenser is provided. This is provided with our patented adjustable spray opening which prevents clogging.

Surface Condenser

1543 Fillmore Avenue, Buffalo, New York

Pointing the Way to Increased Evaporating Efficiency

THE process of evaporation or concentration of solutions consists in removing excess water or other liquid from solutions. It is a very important process and the efficiency and economy with which it is carried out influences to a great extent the success of the industry in which it is used. Evaporation is frequently a preliminary stage in converting liquid solutions to a dry state.

Evaporation may be accomplished in various ways, by direct or waste furnace heat, live or exhaust steam, and even by solar evaporation. Undoubtedly the most economical and effective method is evaporation under vacuum with the use of steam in multiple effect. Wherever possible it is always desirable to utilize exhaust steam, which produces the greatest fuel economy.

Owing to the differing properties and characteristics of liquids it is impracticable from the standpoint of efficiency and operating cost to build an evaporator of one type for handling all liquids. Consequently "Buflovak" Evaporators are built in several distinct types, each one designed to handle a definite class of liquids with the highest degree of efficiency and economy. The various standard types are as follows:

Horizontal Tube Evaporator

For handling common solutions which have no tendency to foam or produce scale, and are to be concentrated or distilled without the separation of salts.

Rapid Circulation Evaporator

Either vertical or inclined, for handling common solutions (without salt separation) but which have a tendency to foam and produce scale. This type is also necessary for delicate liquors and organic solutions which must not be exposed to heat except for the very shortest periods possible.

Vertical Tube Evaporator

Of the crystallizing type, equipped with salt filters, for evaporating and crystallizing solutions containing salts which become insoluble during concentration.

High Concentrator

For liquors which because of their high boiling point or increased viscosity require high steam pressures, combined with quick circulation.

With some liquids it is advisable to use two or more types of evaporators for the different stages of evaporation. For instance, in manufacturing caustic soda from soda ash, the Horizontal Tube or Rapid Circulation type is used for concentrating to 36° Bé., the Vertical Tube type to 48° Bé., and the High Concentrator to 67° Bé. Usually, however, one type is sufficient in each case.

Five Essentials of Efficient and Economical Evaporation

There are certain fundamental requirements in designing and constructing evaporating equipment and the degree of efficiency and economy will largely depend on how well these have been embodied in the evaporator. The most important of these requirements are as follows:

Mechanical Strength – with ample thickness of metal for all important parts.

Uniform Circulation of the Liquid – so as to prevent coating of the tubes.

Proper Distribution of the Steam over the entire heating surface.

Evaporator Properly Proportioned – so as to avoid losses by entrainment and foaming.

Simple Construction – so that the equipment can be operated and easily repaired, when necessary, by unskilled labor.

Evaporators which meet the above standard cannot be built as cheaply as ordinary equipment, but users of "Buflovak" Evaporators have the satisfaction of knowing that every element required for efficiency and economy have been included in their equipment.

Buffalo Foundry & Machine Company

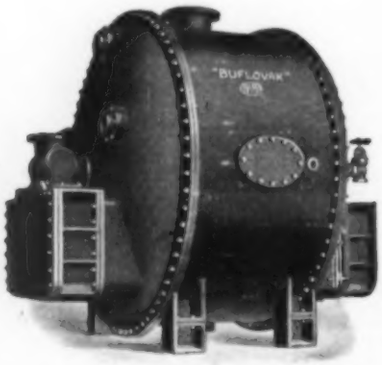
Making a Good Evaporator Better

"Buflovak" Horizontal Tube Evaporator

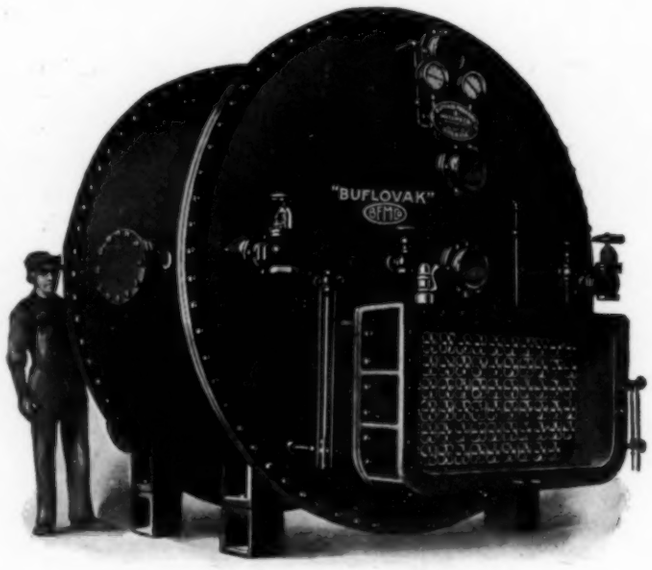
A glance at the illustration almost tells the whole story about the "Buflovak" Horizor al Tube Evaporator. This type was developed from an old evaporator designed nearly seventy years ago. In designing the "Buflovak" our engineers have retained all the good features of the old evaporator and have added several improvements suggested by this long period of service, thus making this type a much more efficient piece of equipment for modern evaporating purposes.

Notice how substantially the evaporator is built. The circular shell and spherical heads provide greater strength than is possible with the flat plates in the rectangular shape as formerly constructed, and ample resistance to inside or outside pressure is secured without excessive wall thickness in the evaporator shell.

This change also provides larger downtakes without unduly increasing the size of the evaporator, thus insuring a rapid and uniform circulation through all parts of the heating surfaces. It also increases the width or area above the liquor level, resulting in reduced vapor speed and consequently the practical elimination of losses by entrainment. The shells are made in one piece up to 12 feet long, thereby reducing to a minimum the number of joints and the chances of leakage.



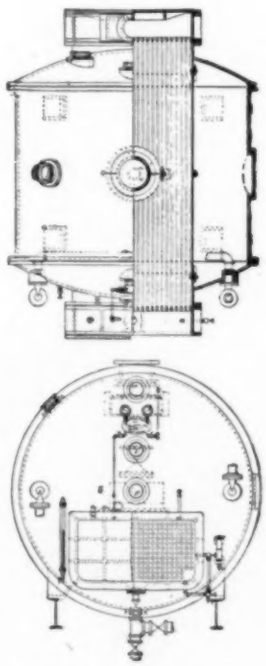
Side and Rear View Showing both steam headers



Front View

Another important advantage is the possibility of enlarging the evaporator by simply adding another cylindrical shell whenever it is desired to secure greater capacity, thus obviating the necessity of discarding an otherwise good evaporator.

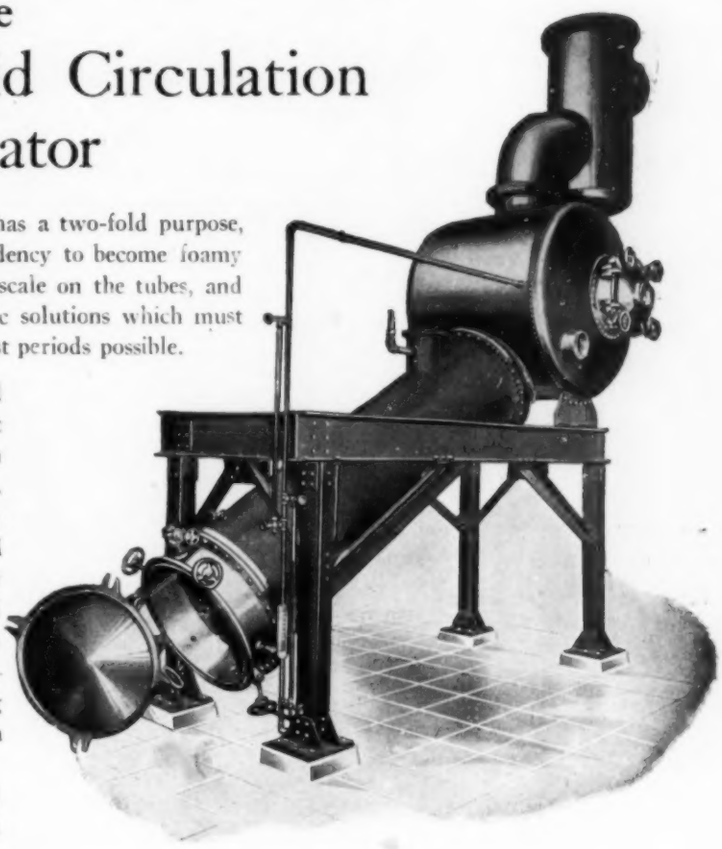
The H. T. Evaporator is built in two standard sizes, 96 in. and 114 in. diameter, the length of the tubes being from 6 ft. to 16 ft. The range of heating surface is from 590 to 2460 sq. ft; also special sizes down to 40 sq. ft. Apparatus can be built of cast iron, steel, copper, bronze, aluminum; also of cast iron or steel and lined with acid-proof material.



Plan and Cross-Section

1543 Fillmore Avenue, Buffalo, New York

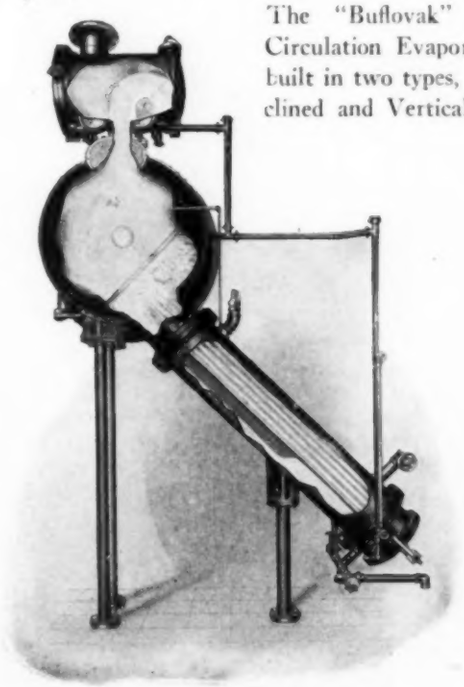
Handling Delicate Solutions Safely in the "Buflovak" Rapid Circulation Evaporator



The "Buflovak" Rapid Circulation Exaporator has a two-fold purpose, first, that of handling solutions that have a tendency to become foamy during evaporation, and which tend to produce scale on the tubes, and second, concentrating delicate liquids and organic solutions which must not be exposed to heat except for the very shortest periods possible.

This evaporator is of the semi-film type and because of the rapid circulation and resultant quick evaporation the liquid is in contact with the heating surface for an extremely short period. This is especially advantageous when drying liquid food products like milk, malt extracts, and delicate organic substances that are unfavorably affected by heat. The flavor of the original product – even of the most delicate liquids – is preserved to a much greater extent than is possible where the liquid is exposed to the heating surface for long periods, as in old type vacuum pans.

The "Buflovak" Rapid Circulation Evaporator is built in two types, the Inclined and Vertical.



Interior View showing course of liquid and vapor

Inclined Type

This type consists of an inclined cylindrical steam chest bolted to a horizontal cylindrical vapor body. The steam is around the tubes, and the liquid inside the tubes. As evaporation takes place, the vapor and some liquid passes upward through the tubes at a high speed and is thrown with considerable force against the baffle plate extending across the vapor body, which causes the vapor and liquid to separate. The liquor returns through the downtake to the main body of liquid for further evaporation, while the vapor passes into the vapor space.

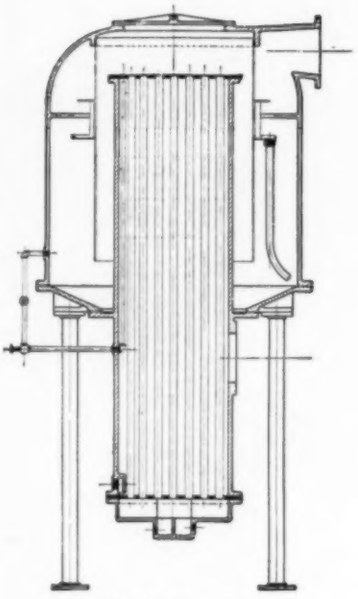
A particular advantage of the inclined type is the ease with which it may be cleaned. The tubes are reached through an easily opened door at the bottom, while the interior of the vapor body is reached through a door on the side.

Buffalo Foundry & Machine Company

Rapid Circulation Evaporator—Continued

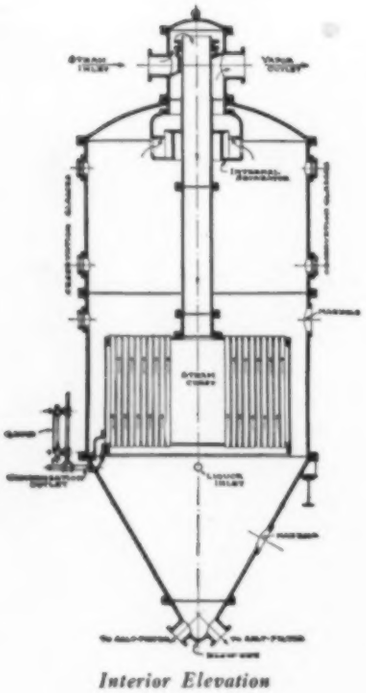
Vertical Type

The vertical type has been developed from the standard vertical tube evaporator, the tube length being increased and liquor space being reduced. As in the inclined type, the rapid circulation of the liquid prevents overheating so that the most delicate liquids can be handled with the utmost safety. The special baffle and tube arrangement eliminates losses caused by foaming and entrainment. This evaporator occupies very little floor space and the erection and operation are quite simple.



Vertical Cross-Section

"Buflovak" Vertical Tube Evaporator



Interior Elevation

Crystallizing Type with Salt Filters

This evaporator has been developed from an old standard evaporator, designed many years ago. The most important change is in the steam chest which formerly was an integral part of the evaporator body, but is now a separate unit. This feature together with the annular downtake affords a better circulation of the solution and assists materially in depositing the salt in the filters. The interior of the steam chest is fitted with suitable baffles and channels for the efficient distribution of the steam and separation of non-condensable gases.

This type evaporator is used mainly for liquors with soluble salts which precipitate during concentration.

1543 Fillmore Avenue, Buffalo, New York

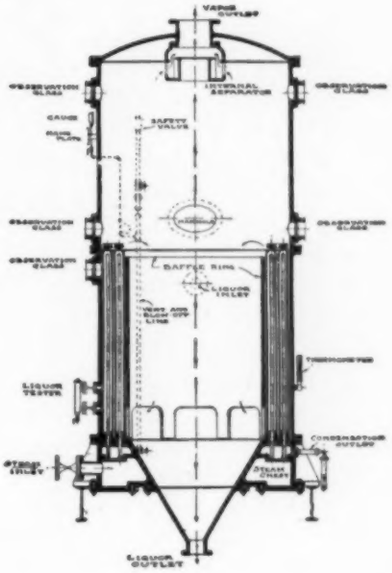
"Buflovak" High Concentrator

ESPECIALLY adapted to the high concentration of caustic soda, potash, ammonium nitrate and electrolytic caustic solutions above 36° Bé. This evaporator produces a very rapid circulation of the liquor, and is designed for concentrating liquids to higher densities than are practicable in other types.

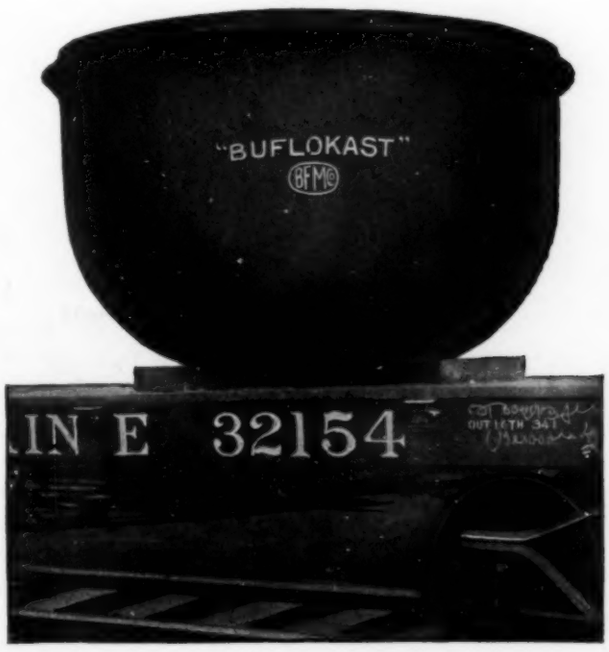
The heating surface is formed by a number of upright special cast iron tubes which are screwed into the flueplate by means of special double extra strong nipples and the machined surfaces of flueplate and tube end are protected from corrosion by special gaskets. This construction makes an absolutely tight joint and permits the replacing of defective tubes by ordinary labor.

The tubes are made of alkali-resisting or acid-resisting iron, copper or special bronze, depending on the nature of the liquor to be concentrated.

Furnished in single or multiple effects, with or without salt separation.



Caustic Pots and Other Caustic Apparatus



The signal success of "Buflokast" Caustic Pots places them in a distinctive class for length of service. Time after time customers have written us and commented on the long periods of service obtained. They are constructed of special metal noted for its success in withstanding the combined action of caustic and high temperatures, Furnished in sizes from 100 to 3200 gallons.

Other caustic equipment includes complete causticizing apparatus, for manufacturing caustic soda from waste carbonate or sulphite liquors by caustification. We furnish complete apparatus for handling waste liquors from soda pulp mills, mercerizing, rubber, explosives, chemical and other industries.

Apparatus furnished for producing flaked caustic.

Buffalo Foundry & Machine Company

Eliminating Difficulties with Efficient Chemical Apparatus

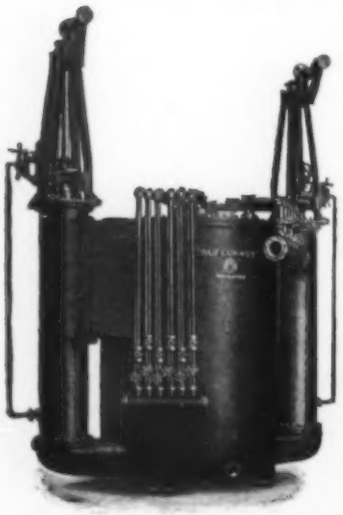
WHILE highly developed chemical processes work out to the *n*th degree in the laboratory, the lack of efficient, properly constructed apparatus brings about many of the difficulties encountered in their application to a commercial production scale. Regardless of the nature of the chemical process, the basic apparatus problem is always the same. Chemical apparatus must be designed and constructed with an intimate knowledge of the process reaction and individual treatment involved, in order to develop a smooth-working efficient operation.

"Buflokast" Chemical Apparatus is built with a thoroughness made possible by the knowledge and direction of practical chemical engineers who thoroughly understand the process difficulties to be overcome. It was our good fortune in designing our standard types of chemical and other apparatus to have on our staff engineers occupying the foremost position in their respective fields.

Nitration

"Buflokast" Nitrator—Hough Type

The Hough Type Nitrator was designed to obtain a high yield and large output with a high degree of safety in operation. These features have been made possible by providing for control of the temperature at the point of reaction, and the rapid incorporation with the acids of the reacting chemical compounds.

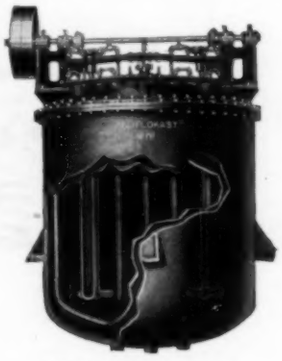


"Buflokast" Nitrator Hough Type

A notable feature is the rapid circulation of the acid which prevents any appreciable rise in temperature at the point of contact of the hydrocarbon and the acid. The safety devices employed make it possible to conduct nitrations much faster and secure a far greater output than with any other type ever used. This apparatus can be used with equal efficiency and safety for nitrating, reducing, sulphonating, chlorinating and other chemical operations. Also adaptable for mixing, blending and washing oils. Special type for nitrating glycerine.

Hough Nitrators are built in large and small sizes.

The standard type "Buflokast" Nitrator is constructed with a cooling jacket, and the larger sizes provided with special closed-end tubes. The jacket is furnished tight or loose as may be required in each case. Single or double agitating shafts are also provided.



"Buflokast" Nitrator Standard Type

The temperature of each cooling tube is individually controlled, thereby regulating the temperature in all parts of the nitrator. This nitrator is substantially constructed throughout. The sizes run from eight gallons to 1600 gallons.

Sulphonation

The "Buflokast" Sulphonator has demonstrated its efficiency by extensive use throughout the chemical industry. The sides and bottom of the apparatus are steam-jacketed, and owing to the action of the acids commonly treated, a special quality of metal is used in its construction.

By placing the propeller shaft at one side of the apparatus, the swirling motion of the liquid is prevented and it produces a more effective agitation than is possible when located centrally.

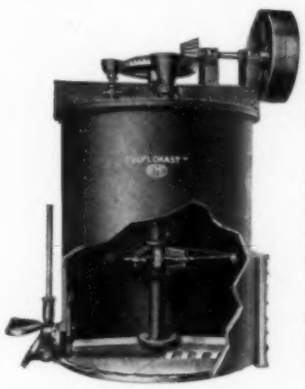
"Buflokast" Sulphonator

1543 Fillmore Avenue, Buffalo, New York

Chemical Apparatus—Continued

For Problems of Reduction

The "Buflokast" Reducer is furnished with or without jacket, depending on the heating facilities desired. The bottom and lower portion of the sides are lined with liner plates made of special metal, which are removable and can be renewed as occasion requires. The shaft and agitator are hollow, steam being introduced through the shaft at the top and distributed in the reducer through the outlets in the agitator. Noted for its large output, and ease and cleanliness of operation.



Standard Type "Buflokast" Reducer

Autoclaves

These have been designed to secure a high degree of safety in operation and should not be confused with ordinary autoclaves. They are built for high and low pressures, constructed of cast-steel, bronze or cast iron, depending on the pressure desired and the material to be treated. Furnished with or without jacket, stirring device and interior lining. Commercial and laboratory sizes.

"Buflokast" Fusion Kettles

The important feature about "Buflokast" Fusion Kettles is the fact that they are made of the same quality of metal used successfully for so many years in the manufacture of our caustic pots. This mixture of metal is designed to resist the combined action of the caustic and the temperature to which the kettles are usually subjected.

"Buflokast" Phenol Stills

The distinguishing feature of this special apparatus is its basic efficiency. It is equipped with a special arrangement for deodorizing the vapors that pass from the still to the condenser.

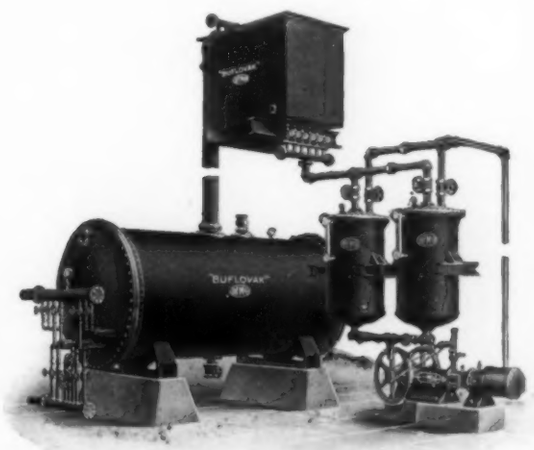
The condenser is arranged for water supply at the bottom and overflow at the top, and is fitted with a special coil to prevent discoloration of the acid.

"Buflokast" Phenol Still

"Buflovak" Aniline and other Vacuum Stills

These are constructed of heavy steel plate and provided with heating coils in the bottom of the still. A gooseneck and vapor pipe extend from the top to a condenser of ample capacity. The still is also provided with two receivers and a vacuum pump.

These vacuum stills—furnished in various sizes, either the horizontal or vertical type—are built in accordance with the high standards of our other vacuum apparatus. Their design has been worked out with exceptional care as to details.



Buffalo Foundry & Machine Company

Chemical Apparatus—Continued

Crystallizing Pans

The wide diversity of products that at some stage of their manufacture undergo the process of crystallization, has led to an extensive study of equipment for this need, adaptable to many products requiring such treatment.

Vacuum Type Crystallizing Pan

"Buflokast" Crystallizing Pans are furnished in the vacuum or atmospheric types depending on the character of the material to be treated. They are used for concentrating and crystallizing various products. The vacuum type is especially adapted for materials requiring low temperatures, and permits the handling of delicate materials, including food products, on account of the lower temperatures employed. It also causes a more rapid crystallization.

The atmospheric type is adapted to materials that do not require vacuum, being used extensively for concentrating and crystallizing ammonium nitrate and similar products.

Note the one-piece construction of the jacket at the bottom of the pan. This eliminates all joints as well as the use of bolts, packing, etc., and removes any chance of leakage through loosening of bolts and opening of joints.

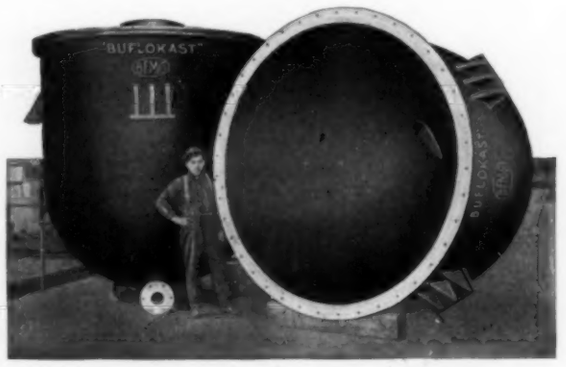
Nitric Acid Equipment

"Buflokast" Nitric Acid Equipment includes complete plants for manufacturing nitric acid, and our well-known "Buflokast" Nitric Retorts, which are furnished independently of the complete plant where desired.

Nitric Retorts

"Buflokast" Nitric Retorts have long since become a standard unit with most of the high explosive companies and other manufacturers of nitric acid. They are designed of such proportions as to give a maximum yield per charge with low cost for furnace settings and operation. Standard sizes up to 3000 gallons capacity. We also manufacture the horizontal type made of the same quality of metal.

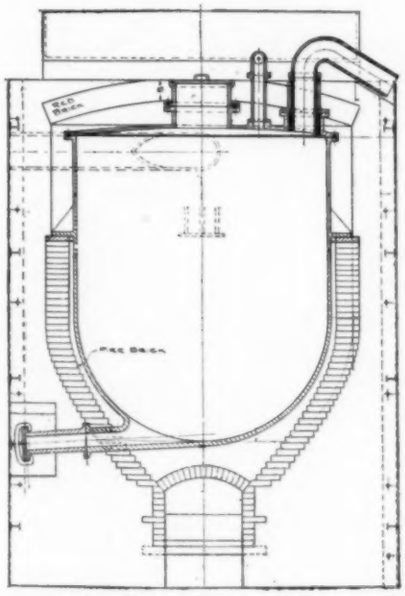
Atmospheric Crystallizer



"Buflokast" Nitric Retorts

1543 Fillmore Avenue, Buffalo, New York

Chemical Apparatus—Continued



Cross-section of Nitric Retort and Furnace Setting

Vacuum Nitric Plant Hough Type

A comparatively recent development is the manufacture of nitric acid under vacuum. The operation of the system under vacuum insures distillation at low temperature and the production of the strongest acid without decomposition. It also increases the safety and ease of operation, decreases the amount of nitrous oxide, and to a large extent reduces the time of operation. The vacuum still is provided with a mechanical agitator which prevents massing of the mixture.

The principal objects secured by the vacuum system are large output, high yield, greater purity of acid, low cost of production, and low upkeep cost of equipment.

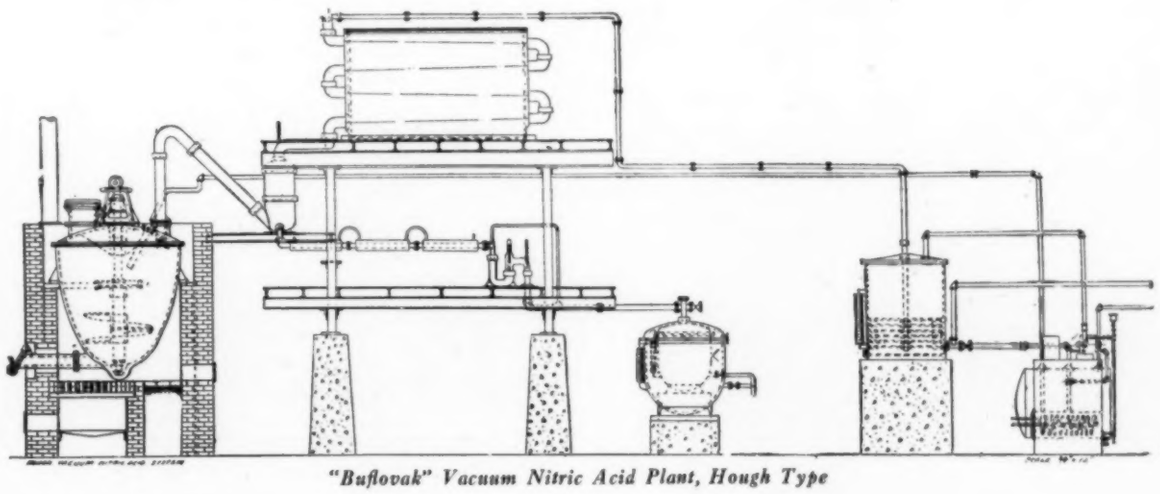
The drawing below shows, in order from the left, the vacuum still, condensing system, bleacher, hydrometer pot, nitric acid receivers, and sulphuric acid tank and scrubber.

Still for Vacuum Nitric Plant

Acid Recovery and Concentration Apparatus

This embraces complete equipment for recovering nitric and sulphuric acids at a high degree of concentration from mixed nitrating acids. A constant temperature is maintained at the top of the denitrating tower without affecting the temperature at the bottom, thereby making it possible to obtain a highly concentrated nitric acid (93% to 96%) and at the same time recover the sulphuric free from organic matter without over-dilution with steam.

The sulphuric concentrator is so constructed that the formation of salts on the metal surface is prevented, thus avoiding reduction of heat conductivity and prolonging the life of the apparatus. Other features are its compactness and low upkeep cost.



"Buflovak" Vacuum Nitric Acid Plant, Hough Type

Buffalo Foundry & Machine Company

Distillation Apparatus and General Coppersmithing

We have recently added to our facilities a coppersmithing department, which will enable us to render a more complete service to our customers. Besides doing all the copper work used in some of our standard vacuum and chemical apparatus, this new department enables us to furnish customers with various types of copper apparatus, including copper distilling apparatus, copper pans, copper coils, copper kettles, copper stills, copper evaporators, copper vacuum pans, etc. We also do general coppersmithing, either in new work or repairs.

Users of copper equipment will be given the benefit of the experience of our engineers in designing and building our general line of chemical and vacuum apparatus.

Rotary Dryer
Engel Type

This atmospheric dryer is intended for drying materials that do not require a vacuum. A special feature of this dryer is our patented disseminating screen which is concentric with the drum. As the shell revolves the material is carried upward by the

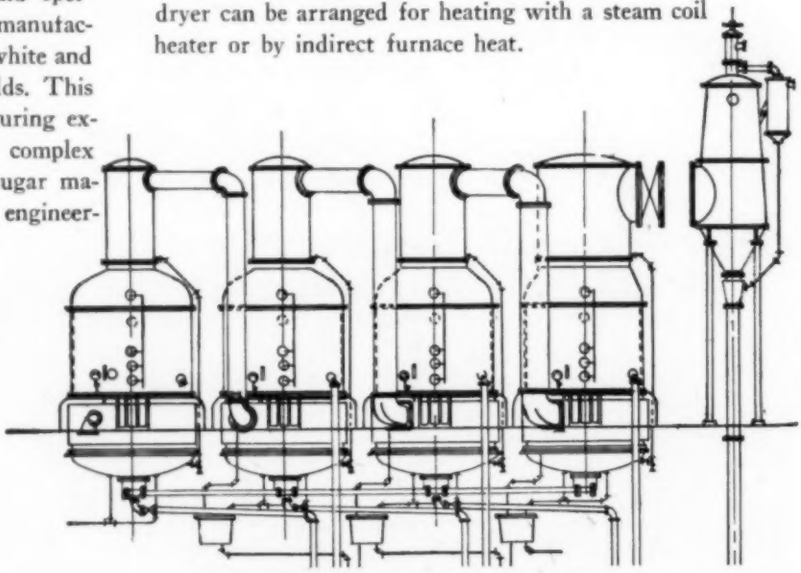
lifting shelves attached to the inside surface of the dryer shell and then falls on the screen which disseminates the material, thus allowing for the free action of the drying air on it. The screen also breaks the fall of the sugar crystals or other materials being dried, thereby preventing to a great extent the breaking up of the crystals into small particles and the consequent formation of dust. The dryer can be arranged for heating with a steam coil heater or by indirect furnace heat.

"Buflovak" Sugar Apparatus

Our Sugar Machinery Department is under the supervision of engineers who have had many years of experience in designing, constructing and operating sugar machinery, including complete manufacturing plants, in the production of brown, white and refined sugars in the cane and beet sugar fields. This experience coupled with a broad manufacturing experience in building similar and more complex apparatus, is your assurance of receiving sugar machinery based on the soundest principles of engineering and manufacturing practice.

Our facilities enable us to manufacture, assemble and test machinery of any weight and size capable of rail or water transportation.

Only a few types of sugar apparatus are shown. Full information regarding any items will be furnished on request..

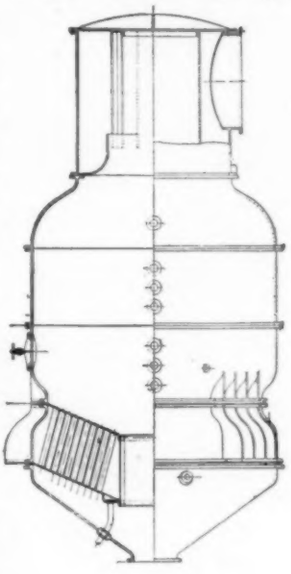


"Buflovak" Quadruple Effect Vacuum Pan

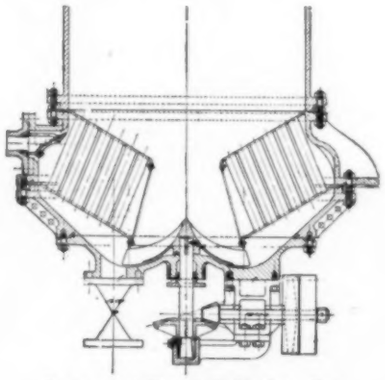
1543 Fillmore Avenue, Buffalo, New York

"Buflovak" Vacuum Pans

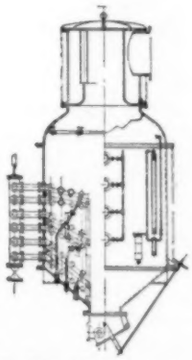
These are built in several types, including the Engel calandria, flat calandria and coil types. The Engel type calandria pan is designed for evaporating, at low temperature and low steam pressure, liquids of various densities, including highly concentrated juices. The heating element is placed at a low point in the pan in order to control the size of the crystal, and finish the crystallization in the same apparatus, instead of distributing the nucleus into several pans to obtain the required size of the crystals. For supersaturated and highly concentrated liquids a propeller is provided at the bottom of the pan. Special calandria and coil type pans are built to order.



Calandria Vacuum Pan Engel Type



Section of Engel Calandria Pan with Propeller



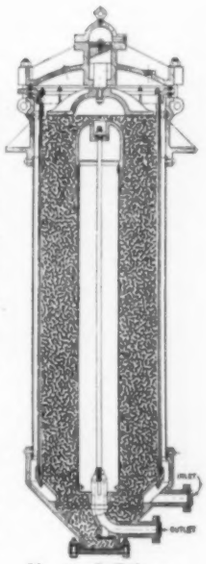
"Buflovak" Vacuum Pan, Coil Type

Bag Filter

Constructed in rectangular and cylindrical types and arranged to permit removal and replacement of heads and bags with the least amount of interruption to operation. Provision is also made so as to prevent a falling bag from closing entirely the discharge opening.

Removable Head for Rectangular Bag Filter

"Buflovak" Vertical Filter



Vertical Filter

Used for filtering with bone black and other filtering mediums. The filtering medium is inserted between two concentric screens contained in the filter. The inner screen and the top of the filtering medium is covered with filter cloth. The filtration takes place through the outer screen, through the filtering medium, into the inner screen and out.

Provision is made against floating of the material and the formation of short circuiting channels. When the filtration is completed the filter is drained, and the impurities are removed by blowing steam through the filtering medium in the opposite direction, this cycle being repeated until necessary to renew the filtering materals.

Special Sugar Apparatus and Castings

In addition to our standard sugar apparatus we build to order special apparatus either according to specifications submitted by our customers or those drawn up by our engineers to fit the special requirements.

We also have exceptional facilities for making special castings for sugar work, including belts, domes, cones, etc., for sugar and syrup evaporators; with or without machine work.

Special Calandria for Vacuum Pan

Buffalo Foundry & Machine Company

Concentrating Pan for Hydrochloric Acid

Special Dissolving Tanks

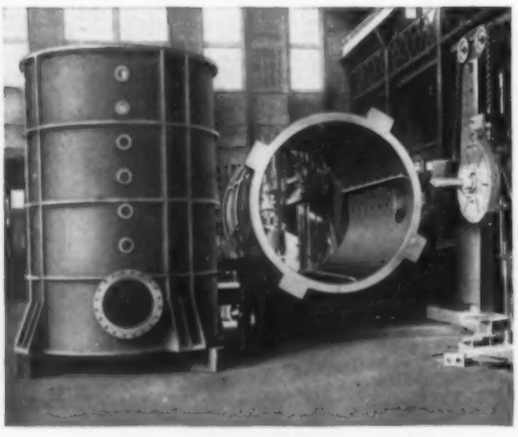
Horizontal Acid Egg

Special Chemical Castings

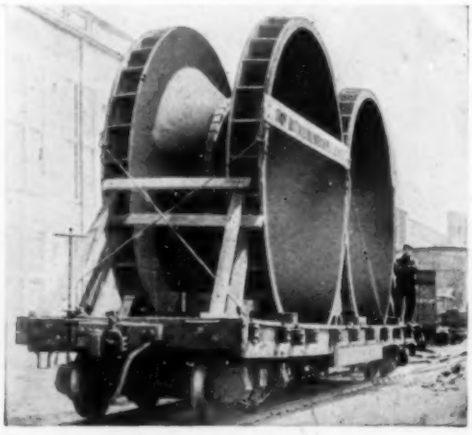
An important part of our service is the manufacture of special castings for chemical, heat-resisting and other special requirements, these castings having qualities not found in ordinary castings. The materials for such castings are carefully analyzed and the metal compositions produced with laboratory exactness. The result is a finished casting of known quality with physical and chemical properties suited to the conditions it is to meet. Our facilities enable us to furnish special castings in any size that can be transported by rail.

Special Jacketed Kettle

Vertical Acid Egg



Special Retort Castings being machined



Steep Cone Bottoms Ready to Ship

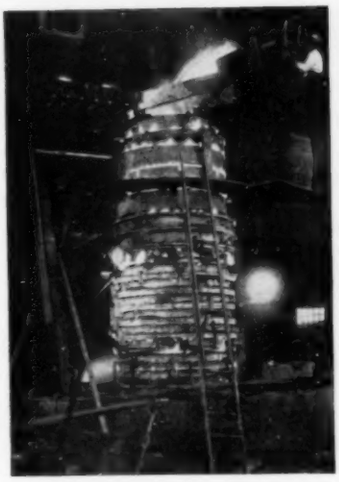
1543 Fillmore Avenue, Buffalo, New York

Machine Shop View

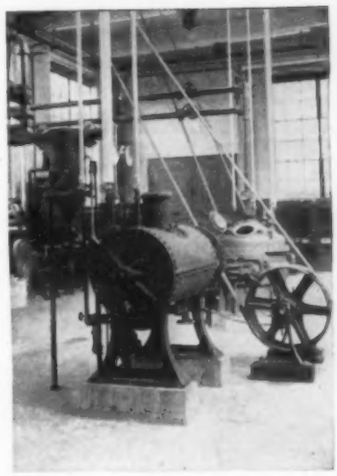
Foundry View

Facilities

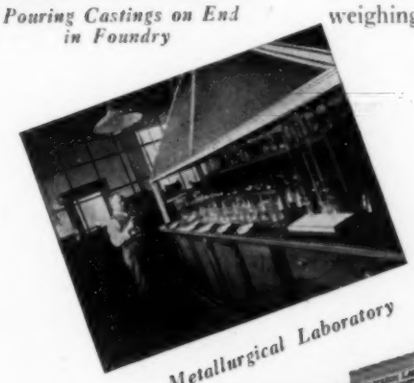
Our plant is well equipped in every way for the production of the various lines of apparatus we manufacture. It consists of fully equipped foundry, machine shop and pattern shop buildings, commodious storage buildings and yards, power house, executive and engineering buildings, research laboratories, the latter including well-arranged chemical and metallurgical laboratories, and a testing plant for experimental work in vacuum drying, evaporating, various chemical and other operations. This equipment permits of the manufacture and assembling of as large and heavy machinery as can be transported by rail or water. The foundry facilities enable us to make castings weighing up to 200 tons each.



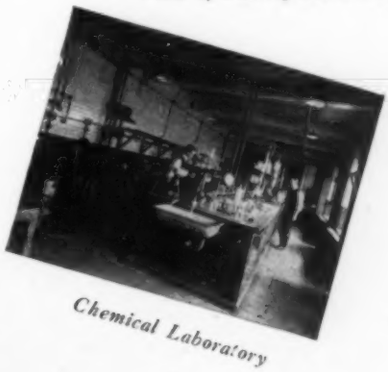
Pouring Castings on End in Foundry



View of Testing Laboratory



Metallurgical Laboratory



Chemical Laboratory

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Dry Vacuum Pumps
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Vertical Tube Evaporators
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"Buflokast" Chemical Apparatus

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Beta Naphthol Stills
Phenol Stills
Autoclaves
Nitric Retorts
Denitrators
Acid Eggs
Crystallizers
Complete Nitric Acid Plants
Hydrochloric Acid Pans
Concentrating Apparatus for Nitric and Sulphuric Acids
Recovery Systems for Nitric and Sulphuric Acids
Special Chemical Castings

Copper Distillation Apparatus and General Coppersmithing; Copper Pans, Coils, Kettles, Stills, Evaporators, Vacuum Pans, etc. New work and repairs.

"Buflovak" Sugar Apparatus

Vacuum Pans, Evaporators, Dryers, Filters, Crystallizers
Granulators, Condensers, Coolers and other sugar machinery
Special Sugar Mill Castings

Many of the above items are briefly described in the preceding pages. Complete information will be sent on request.

BUFLOVAK

No. 4

OF A SERIES OF ARTICLES PICTURING THE INFLUENCE OF THE ENGINEER IN THE AFFAIRS OF THE WORLD. PRESENTED BY THE McGRAW-HILL COMPANY, INC., WHOSE PUBLICATIONS HAVE SERVED THE ENGINEER THROUGH HALF A CENTURY OF INDUSTRIAL PROGRESS

THE BREADTH OF ECONOMICS

AN old word with a new meaning has been introduced into the affairs of men. The power of words is very great and an understanding of them is one of the essentials to progress.

¶ The advancement of humanity hinges, to an almost menacing extent, upon a complete conception of the word *economics*. Once popularly confined to finance, it has grown to involve the whole realm of human activity.

¶ Now man is the economic factor in the work of the world. Whatever he does, the result—time, effort, ability and resources engaged—must prove up under the standards of economics, or be judged unworthy.

¶ But who has brought about this change, this revision in the conception of man's advancement, of man's inevitable responsibility? And who has given this word so vast a power over human destinies and has caused so gigantic a revolution for the benefit of all humanity?

¶ The engineer. His is the responsibility. He it is who has introduced economics into all the affairs of men. He it is who has provided the world with a new basis for judgment and appreciation.

¶ The engineer, who has made life assume a scientific instead of a chaotic aspect; who has developed an exactness of procedure; who has worked out cause and effect on a calculable basis; who is even now reducing the fever of misapplication of life's priceless energies and putting them to the service of constructive happiness.

¶ It will be many generations before the mass of humanity knows and acknowledges its debt to the engineer, who so quietly brings about such stupendous revolutions and revelations, and who takes the past and links it to the present for the benefit of the future.

¶ Yet while the acknowledgment may be long in coming, the engineer has his reward in the knowledge of work well done, in the joy of accomplishment, in the feeling of power which gives him the opportunity to direct the courses of men even before they are aware of the source of authority.

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Electrical Merchandising

American Machinist

Industrial Engineer (Published in Chicago)

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American Machinist European Edition (London)

Power

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Electric Railway Journal

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Chemical and Metallurgical Engineering

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McGRAW-HILL COMPANY · INC ·

NEW YORK

FROM GILBERT'S

DE MAGNETE —

"WORD MONGERS" *and* "CHATTERING BARBERS"

"Word mongers" and "chattering barbers," Gilbert called those of his predecessors who asserted that a wound made by a magnetized needle was painless, that a magnet will attract silver, that the diamond will draw iron, that the magnet thirsts and dies in the absence of iron, that a magnet, pulverized and taken with sweetened water, will cure headaches and prevent fat.

Before Gilbert died in 1603, he had done much to explain magnetism and electricity through experiment. He found that by hammering iron held in a magnetic meridian it can be magnetized. He discovered that the compass needle is controlled by the earth's magnetism and that one magnet can remagnetize another that has lost its power. He noted the common electrical attraction of rubbed bodies, among them diamonds, as well as glass, crystals, and stones, and was the first to study electricity as a distinct force.

"Not in books, but in things themselves, look for knowledge," he shouted. This man helped to revolutionize methods of thinking—helped to make electricity what it has become. His fellow men were little concerned with him and his experiments. "Will Queen Elizabeth marry—and whom?" they were asking.

Elizabeth's flirtations mean little to us. Gilbert's method means much. It is the method that has made modern electricity what it has become, the method which enabled the Research Laboratories of the General Electric Company to discover new electrical principles now applied in transmitting power for hundreds of miles, in lighting homes electrically, in aiding physicians with the X-rays, in freeing civilization from drudgery.

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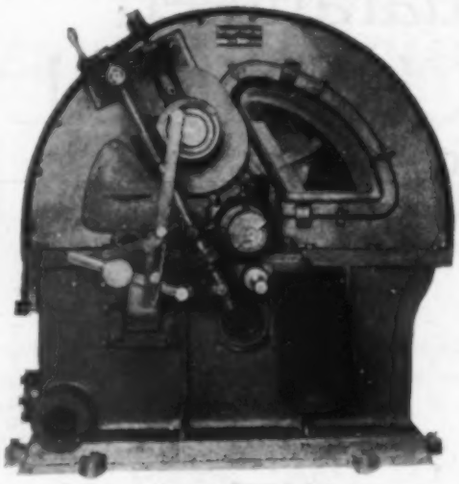

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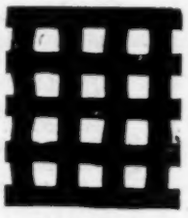
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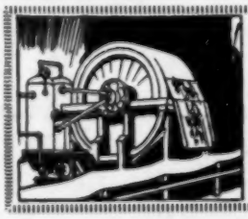

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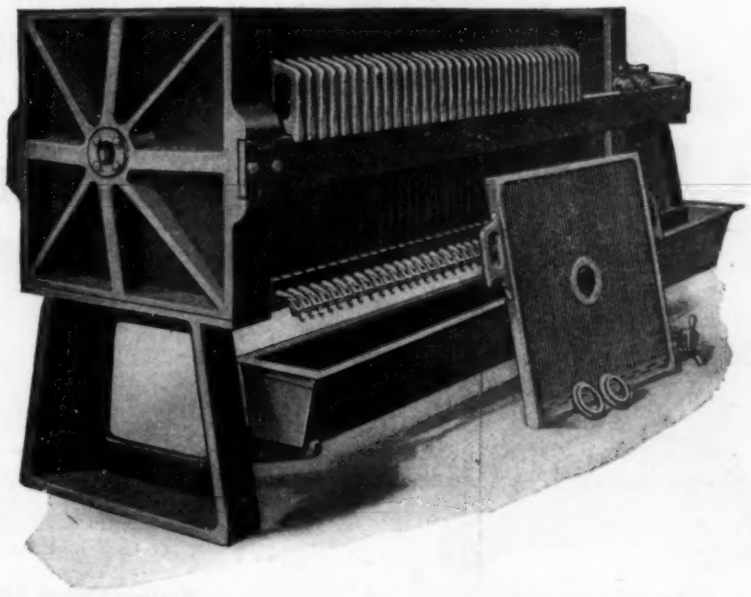

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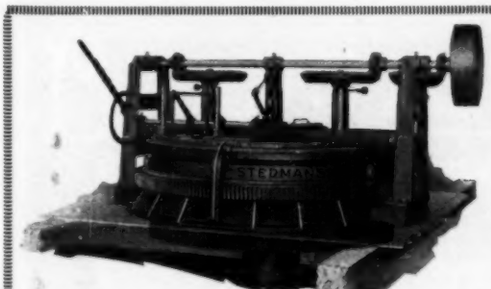

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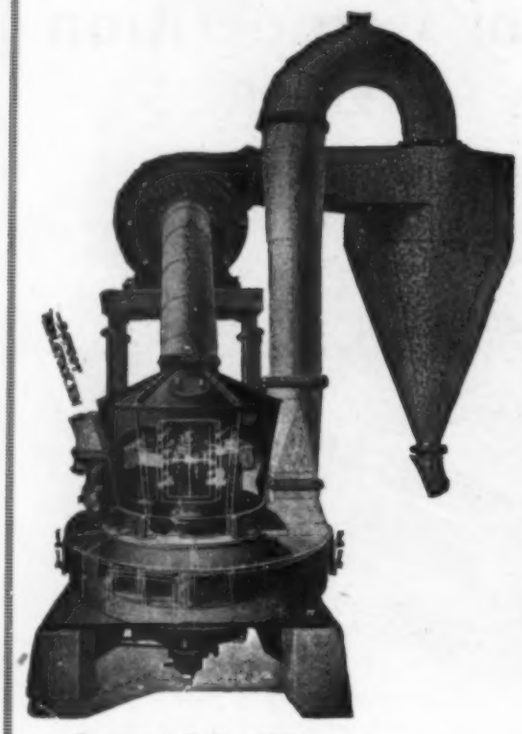

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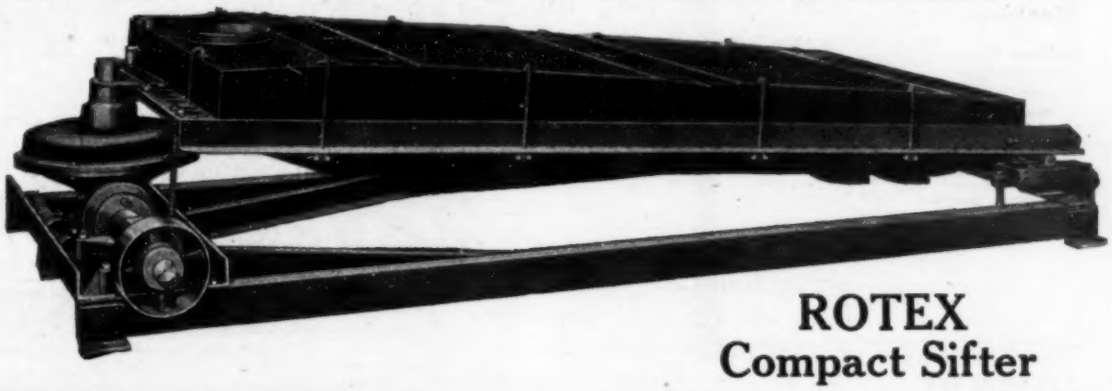

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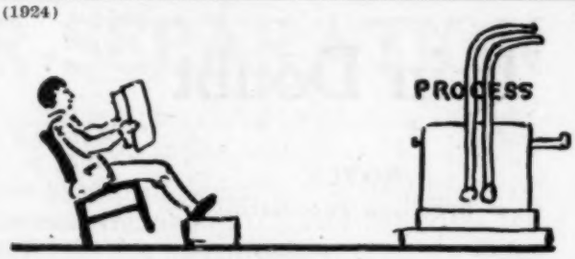

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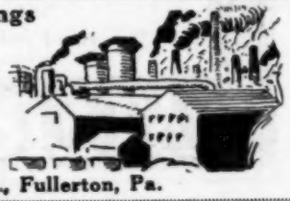

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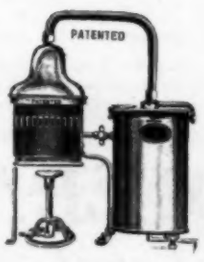

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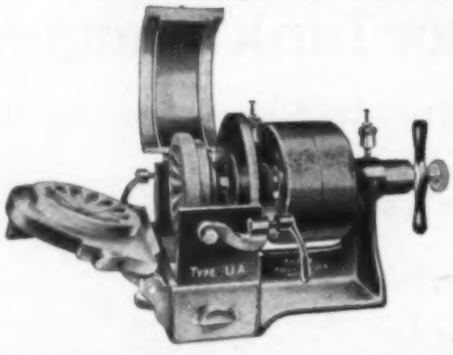

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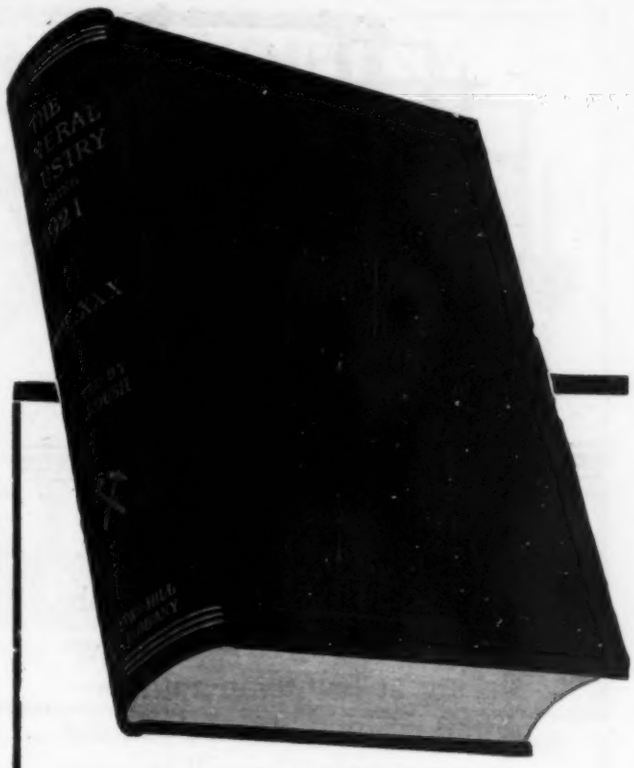

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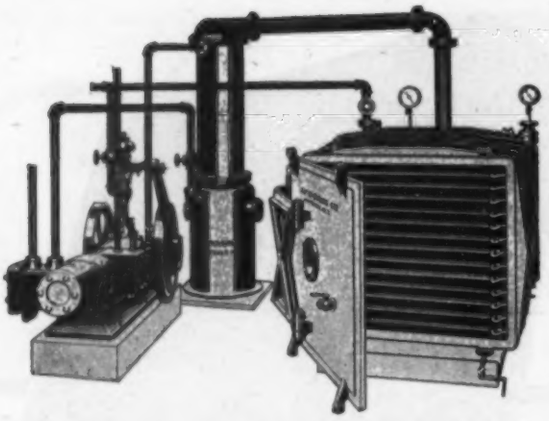

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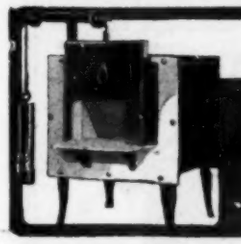

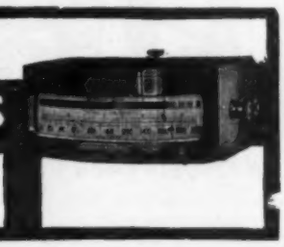

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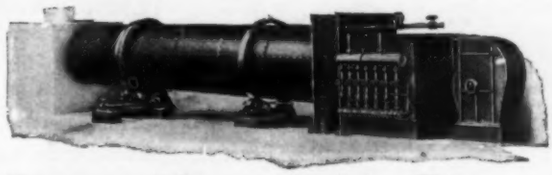

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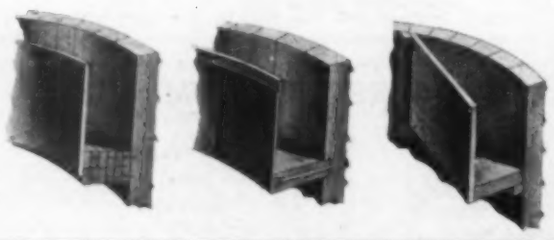

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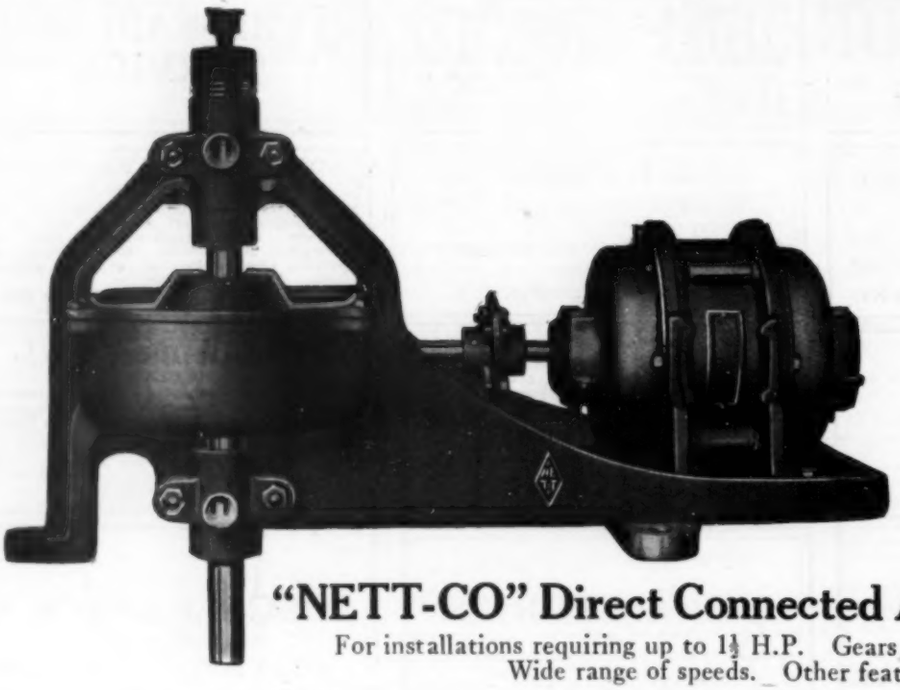

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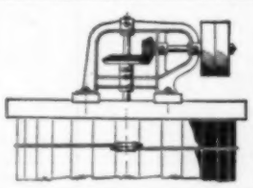

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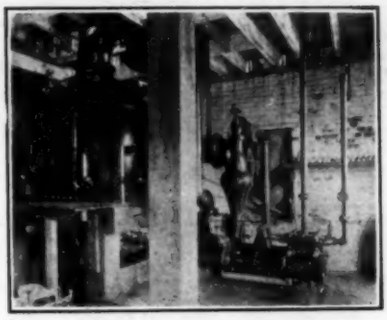

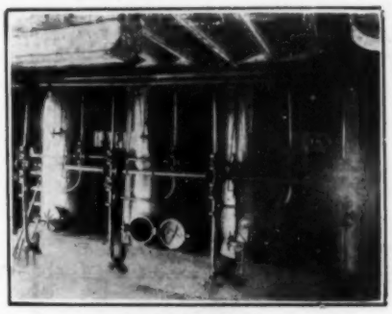

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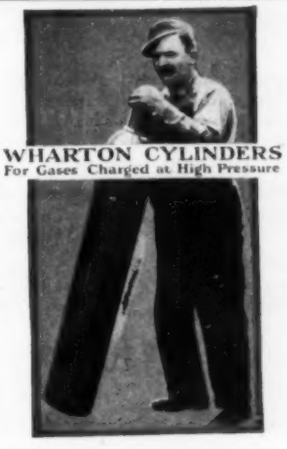

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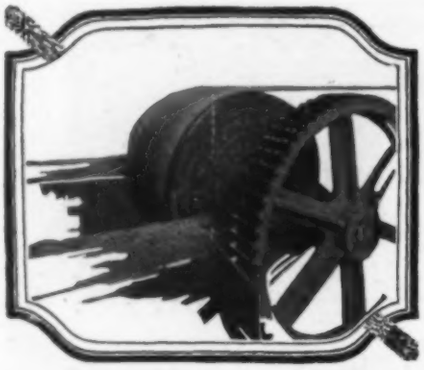

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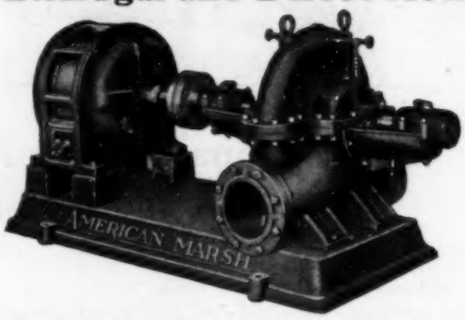

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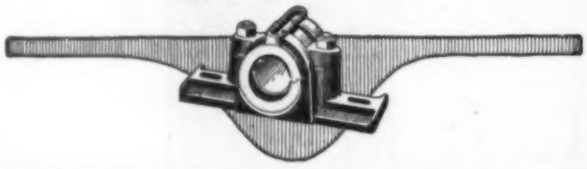

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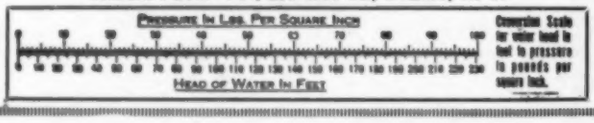
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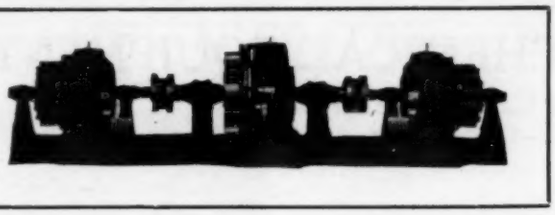

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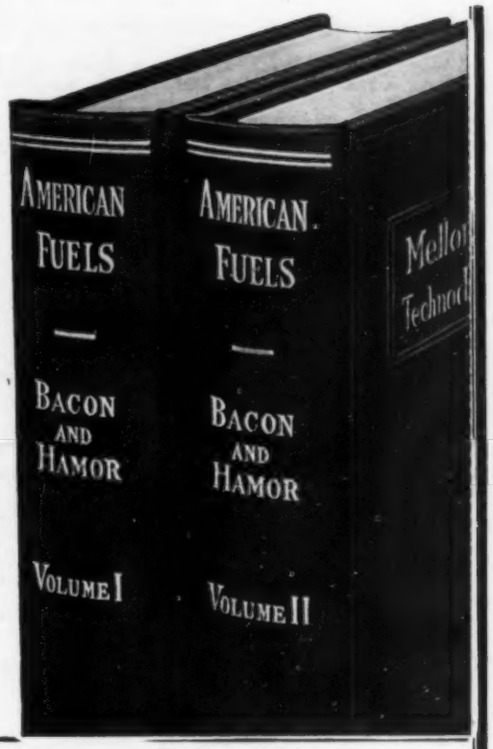

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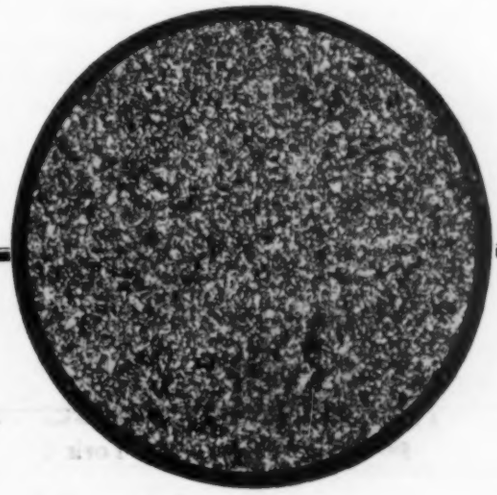

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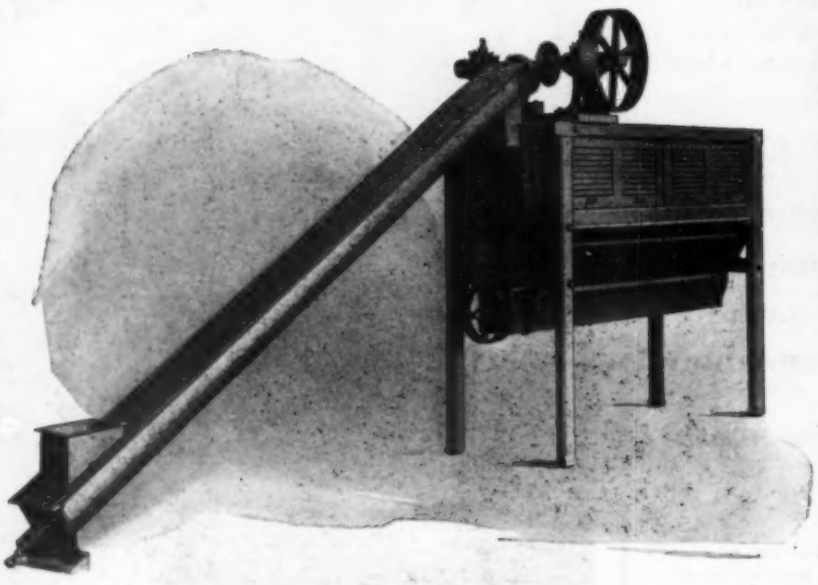

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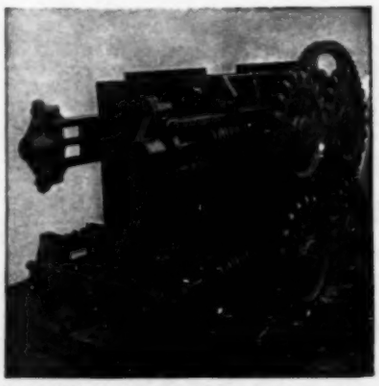

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A Classified Index of Advertisers in this Issue

For Alphabetical Index See Last Page

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Acid Concentration App.
Buffalo Fdry. & Mach. Co.
Duriron Co.
Pacific Foundry Co.

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Stevens-Alysworth Co.

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Nickle Eng. Works

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Parks-Cramer Co.
Sturtevant Co., B. F.

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Sullivan Machinery Co.

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See Meters, Flow, Air, etc.

Air Receivers & Aftercoolers
Ingersoll-Rand Co.
Parks-Cramer Co.
Petroleum Iron Works

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See Metals & Alloys
Calorizing Co. of Pgh.
Scovill Mfg. Co.
Titanium Alloy Mfg. Co.

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See Meters, Flow, Air, etc.

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See Stoneware, Chem. etc.

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Pennsylvania Salt Mfg. Co.

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See Meters, Flow, Air, etc.

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See Pipe & Fittings

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Petroleum Iron Works
Ryerson & Son

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Petroleum Iron Works
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Philadelphia Drying Mach. Co.

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Dings Magnetic Separator Co.

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Beach-Russ Co.
Oliver Continuous Filter Co.

Pumps, Air Lift
Ingersoll-Rand Co.

Pumps, Centrifugal
Abbe Engineering
American Well Works
Beach-Russ Co.
Duriron Co.
Fairbanks, Morse & Co.
Gardner Governor Co.

Ingersoll-Rand Co.
Nash Engineering Co.
Taber Pump Co.

Pumps, Gas or Liquid
Abbe Engineering
Beach-Russ Co.
Devine Co., J. P

Pumps, Rotary
Abbe Engineering
Beach-Russ Co.
Connersville Blower Co.
Ingersoll-Rand Co.

Pumps, Steam
Amer. Steam Pump Co.
Ingersoll-Rand Co.

Pumps, Vacuum
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Commercial Solvents Corp.

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Bristol Co., The

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Bailey Meter Co.

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Kellogg Co., M. W.

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Calorizing Co. of Pgh.

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Taylor Instrument Co.

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Bartley Crucible Co., J.

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Tyler Co., W. S.

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American Tool & Mach. Co.

Separators, Gas
Petroleum Iron Works

Separators, Incline, Vibrating Screens
Tyler Co., W. S.

Separators, Magnetic
Dings Magnetic Separator Co.

Separators, Oil & Steam
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Scovill Mfg. Co.

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Steel, Fabricated
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Sharpsville Boiler Works Co.

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Steps, Safety
Irving Iron Works

Stills, Heating
Bethlehem Fdy. & Mch. Co.

Stills, Oil, Tar, Etc.
Kellogg Co., M. W.
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Tanks, Acid Proof, Stoneware
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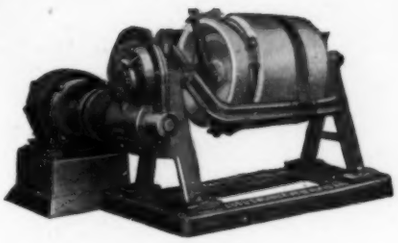

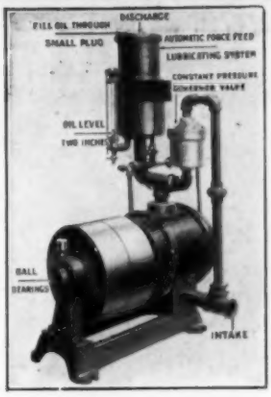

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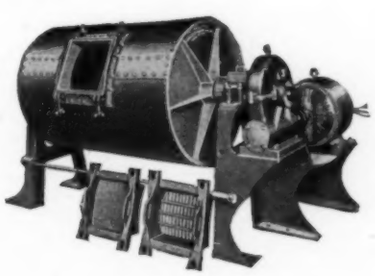

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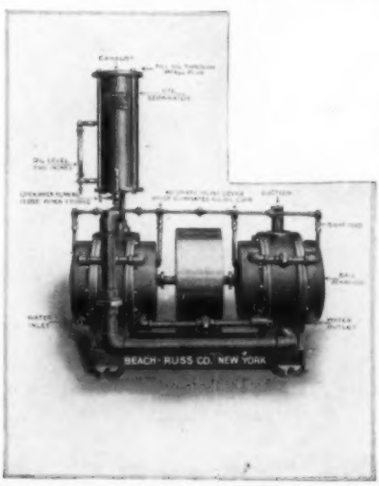

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